MINERAL DEVELOPMENT DIVISON
DEPARTMENT OF MINES
GOVERNMENT OF NEWFOUNDLAND AND LABRADOR

# REPORT OF ACTIVITIES FOR 1987

St. John's, Newfoundland
1987

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# REPORT OF ACTIVITIES FOR 1987

Compiled by
D.G. Walsh

St. John's, Newfoundland
1987

91-04069/

The following projects, as numbered in the Table of Contents, are contributions to the **Canada-Newfoundland Subsidiary Agreement on Mineral Development, 1984-1989:**

**2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 14, 15, 17, 18, 19, 21, 22, 23, 25, 27, 28, 33, 38**

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**1, 9, 13, 16, 20, 24, 26, 29, 30, 31, 32, 34, 35, 36, 37, 38**

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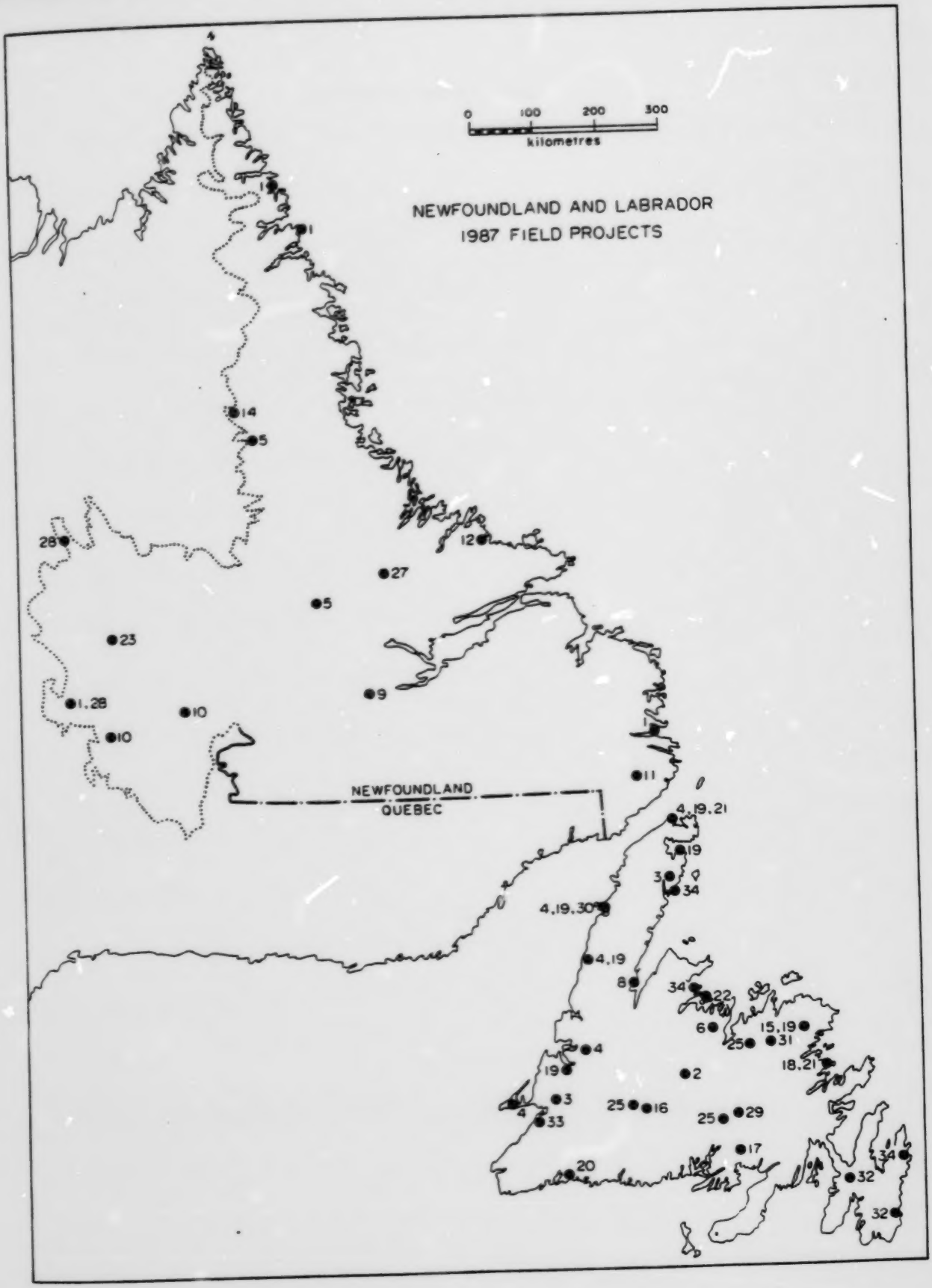
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NEWFOUNDLAND AND LABRADOR
1987 FIELD PROJECTS
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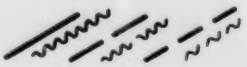
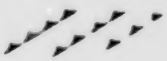
## GEOLOGICAL MAP SYMBOLS

Geological contact (defined, approximate, assumed, gradational)

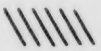
Fault (defined, approximate, assumed)



Thrust fault (defined, approximate, assumed)

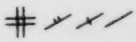


Zone of numerous imbricate thrust faults



Bedding, tops known (horizontal, inclined, vertical, overturned)

Bedding, tops unknown (horizontal, inclined, vertical, dip unknown)



Pillow bedding, tops known (inclined, vertical)

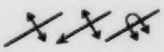
Flow banding (inclined, vertical)

Fracture cleavage (inclined, vertical)

Syncline, showing direction of plunge (defined, approximate)

Anticline, showing direction of plunge (defined, approximate)

Antiform (horizontal, plunging, overturned)

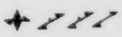


Synform (horizontal, plunging, overturned)

Minor fold axis (with plunge)

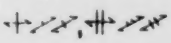
S folds, Z folds

Gneissic foliation (horizontal, inclined, vertical, dip unknown)



Schistosity, cleavage, foliation (horizontal, inclined, vertical)

$S_1$, $S_2$



Foliation due to thrusting (inclined, vertical)

Lineation, fold axis, mineral rodding

Jointing (horizontal, inclined, vertical)

Primary igneous layering (inclined)

Shear zone (approximate)

Alteration zone

Unconformity

Contact inferred from magnetic anomaly

Glacial striae

Drift covered area

Topographic lineaments from aerial photographs

Road

Power transmission line

Mine


Mineral Occurrence


Location of measured section

## Abbreviations

| | | | |
|---|---|---|---|
| Arsenopyrite | asp | Iron formation | i-f |
| Asbestos | asb | Magnetite | mag |
| Chalcopyrite | cp | Molybdenite | mo |
| Copper staining | cs | Pyrite | py |
| Fluorite | fl | Pyrrhotite | po |
| Galena | gn | Radioactive minerals | ra |
| Hematite | hem | Serpentine | sup |
| | | Sphalerite | sp |

Chemical symbols are used for elements, e.g. Cu.....copper.

ECONOMIC GEOLOGY

# INDUSTRIAL MINERALS AND GEOCHEMICAL FOLLOW-UP IN LABRADOR

by

J.R. Meyer and P.L. Dean
Mineral Deposits Section

## Introduction

The 1987 industrial minerals program in Labrador (Figure 1) consisted of: 1) a continuation of the evaluation of silica and dolomite resources; 2) an investigation of several graphite and kyanite occurrences; and 3) additional sampling and mapping of a dimension stone prospect.

Geochemical follow-up work was carried out in the Port Hope Simpson map region in southeastern Labrador, and in the Saglek Bay and Ramah Bay areas along the northern Labrador coast (Figure 1).

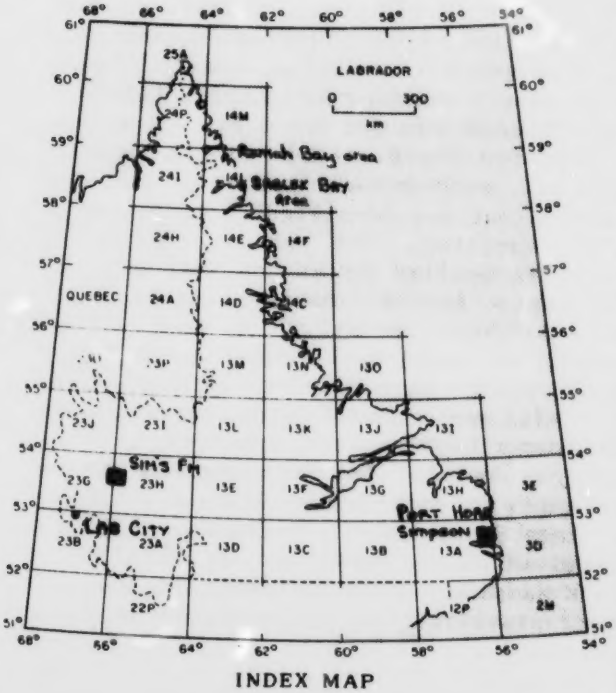



**Figure 1:** Location map showing study areas for 1987.

## INDUSTRIAL MINERALS

### Labrador West

The "Sims's Quartzite" was sampled as part of an evaluation of silica resources in Labrador. The Proterozoic Sim's Formation consists of 100 m of fluvial arkose and conglomerate overlain by 600 m of dominantly marine quartz arenite. Geochemical analyses reported in a thesis by Mike Ware (1983) indicate that the quartz arenite contains less than 2 percent impurities, (dominantly $Al_2O_3$). The Sim's Formation is well exposed in four separate outliers which are close to the Esker-Churchill Falls road. Stratigraphic sampling of over 500 m of quartzite was carried out on the well-exposed Sim's Outlier, and grab samples were collected from the other three.

Several kyanite and graphite occurrences were investigated in the Labrador City/Wabush area. The occurrence which appears to have the best economic potential is the Flora Lake kyanite prospect which has been described by Boyko (1953) and Rivers (1978). Crystals of blue kyanite, up to 5 cm long, occur in a garnet-mica-quartz gneiss (which is often closer to a schist). The prospect consists of a 30- to 50-m-wide zone, within a north-trending ridge that extends along strike for at least 1 km. This zone contains up to 20 percent kyanite, 10 to 20 percent garnet (crystals up to 1.5 cm), and 10 to 15 percent mica (dominantly muscovite). All three minerals would have economic potential if they could be efficiently separated from the host rock.

Road construction on the Trans-Labrador highway, between Emeril and Twin Falls, has intersected several pegmatite deposits. Biotite crystals, 25 cm by 15 cm, were sampled by Rod Klassen and Frank Thompson of the Geological Survey of Canada and kindly passed on to the department. There is potential for other economic minerals in pegmatite deposits in this area.

## Northern Labrador

Detailed mapping and sampling of chert and dolomite units within the Ramah Group, was carried out on the northern Labrador coast in 1987. The Ramah chert is well known by archaeologists as a source of lithic material used by prehistoric cultures in Labrador, and may have been the first industrial mineral exploited in Labrador. The chert occurs as a conspicuous 2- to 12-m-thick unit within a 500-m-section of mudstone and shale (slate). It is thin to thick bedded, often interbedded with 1- to 10-cm-thick mudstone or dololutite beds. The chert is white (translucent) to black in colour, depending on the amount of interstitial graphite (Lazenby, 1980), and contains minor amounts of disseminated pyrite. Four sections were mapped and sampled, and geochemical analyses will be carried out to see if specific beds are of high enough quality to warrant selective quarrying. Underlying the chert in most sections, is a 1- to 4-m-thick unit of massive pyrite. The pyrite varies from finely laminated, to brecciated with abundant inclusions of graphitic shale and quartz.

Directly below the shale section, there is a yellow-weathering secondary dolomite unit (Knight and Morgan, 1976). This unit is 3 to 20 m thick, medium to thick bedded, and contains quartz/chert veins and lenses. Two sections of dolomite were sampled and described.

Graphite was briefly mined at the west end of Saglek Fiord in 1942 (personal communication, G. Etchegary). The site was revisited, sampled and described this past summer. A 40- to 50-cm-thick lense of coarse flake and amorphous graphite occurs in a quartz-feldspar-garnet-mylonite on the side of a moderately steep slope. The graphite lense is remarkably free of impurities and extends beyond the present exposure of approximately 8 m.

# GEOCHEMICAL FOLLOW-UP

## Southeastern Labrador

Lake sediment geochemistry released by the Geological Survey of Canada for southeastern Labrador (GSC Open file 1102) indicates many multi-element anomalies near the coast where overburden is thin. Using recent maps put out by Gower et al. (1987) for the Port Hope Simpson map region, geochemical follow-up was carried out and consisted of rock and silt sampling. The most exciting prospect sampled is at New York Bay, adjacent to a As-Cd-Mo-Ag-Hg-Cu lake-sediment anomaly. A zone of quartz veining, hydrothermal brecciation and intense potassic alteration $\pm$ pyrite was sampled from shoreline exposures. This vein system and others observed in the area may be related to post-Grenvillian plutons or Late Precambrian - Early Paleozoic dykes mapped by Gower et al. (1987). Rock samples collected from this area are presently being analyzed for gold.

## Northern Labrador

A brief geochemical follow-up program was carried out to investigate As-Sb-W-Ni-U-Mo-Pb lake-sediment anomalies in the Saglek Bay area (GSC Open File 1210). A mid-summer release of stream-sediment data confirmed the above anomalies, with the addition of a large gold anomaly on the west side of Tor Bay (GSC Open file 1354). The area immediately to the west of the Saglek airfield, referred to as the The Domes, consists dominantly of quartzo-feldspathic gneisses and metasedimentary and metavolcanic supercrustals with associated mafic and ultramafic rocks. A major north-south basement fault, that cuts through St. John's Harbour, separates amphibolite facies in the east from granulite facies to the west. There may have been Paleozoic reactivation of this and other related faults, (personal communication, D. Bridgewater, 1987). Scintillometer readings of 8000 to 9000 c.p.s. were recorded from coarse crystalline leucocratic rocks adjacent to a uranium anomaly and molybdenite mineralization was observed in rusty gneisses. The mineral rights have recently been acquired by Equity Silver Mines Ltd. of Vancouver.

In the Ramah Bay and Nachvak Fiord region, stream-sediment anomalies include Zn and/or Au, which are occasionally associated with As-Pb-Mo-Hg-Ag. The anomalies occur dominantly within the Ramah Group, but also within the Archean-aged basement. Rusty-weathering slates are very common, especially where intruded by diabase sills. Both these units carry sulphides and were extensively sampled when coincident with Au $\pm$ Zn anomalies. Several other anomalies may be related to previously reported mineralization (Morgan, 1975), including sphalerite within a 10-m-thick dolomite unit, and galena veins within Archean rocks. Ultramafic rocks south of Little Ramah Bay were sampled for Au and PGE mineralization.

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1953: Report on the Wabush Lake Area, Labrador. NALCO Unpublished report. Nfld. MDD File - Lab.(668).

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1987: Geology of the Port Hope Simpson Map Region, Grenville Province, Eastern Labrador. In Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 87-1, pages 183-200.

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1983: The Archean-Proterozoic boundary in the Saglek Fiord Area, Labrador. In Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-1, pages 91-98.

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1983: Depositional history and stratigraphy of the Aphebian Tamarack Formation and the Paleohelikian Sim's Formation, western Labrador. M.Sc. thesis, Memorial University of Newfoundland, St. John's, Newfoundland, 119 pages.

# Granite-related mineralization in Newfoundland, and compilation of gold data in Newfoundland

by

John Tuach
Mineral Deposits Section

## Granite-related mineralization

Work is continuing on data compilation, petrographic studies, mineral identification and report preparation. Emphasis is on the Ackley Granite, the Cross Hills plutonic suite, the Granite Lake area, the Chetwynd Granite and the Gull Lake intrusive suite. Limited field work was conducted in the Crippleback Lake area in central Newfoundland, and samples were collected for geochemical analyses.

## Data on gold occurrences

A list of gold occurrences and deposits in Newfoundland with accompanying brief descriptions (Table 1) and a location map (Figure 1) was released as opne file 1510 (Tuach, 1987). The map is available as a transparent overlay to the 1:1,000,000 scale geological map of the Island, and emphasizes the association of gold, faults and thrusts, and hydrothermally altered rocks (including carbonatized and serpentinized ultramafic rocks). The file is being updated on a regular basis as new data become available, and will be re-released in 1988. An updated version of "Gold-bearing Geological Environments in Newfoundland" (Dean et al., 1985) is being prepared in cooperation with other geologists of the Mineral Deposits Section, and a series of displays on the geology of gold projects in Newfoundland is being constructed.

Detailed petrographic studies and microprobe analyses were performed on rocks from the Jackson Arm gold system in White Bay (Saunders and Tuach, this report).

## References

Dean, P.L., Swinden, H.S., O'Driscoll, C.F., Tuach, J. and Kean, B.F.
1985: Gold-bearing geological environments in Newfoundland. Newfoundland Department of Mines, Mineral Development Section, Open File NFLD 1510, 41 pages.

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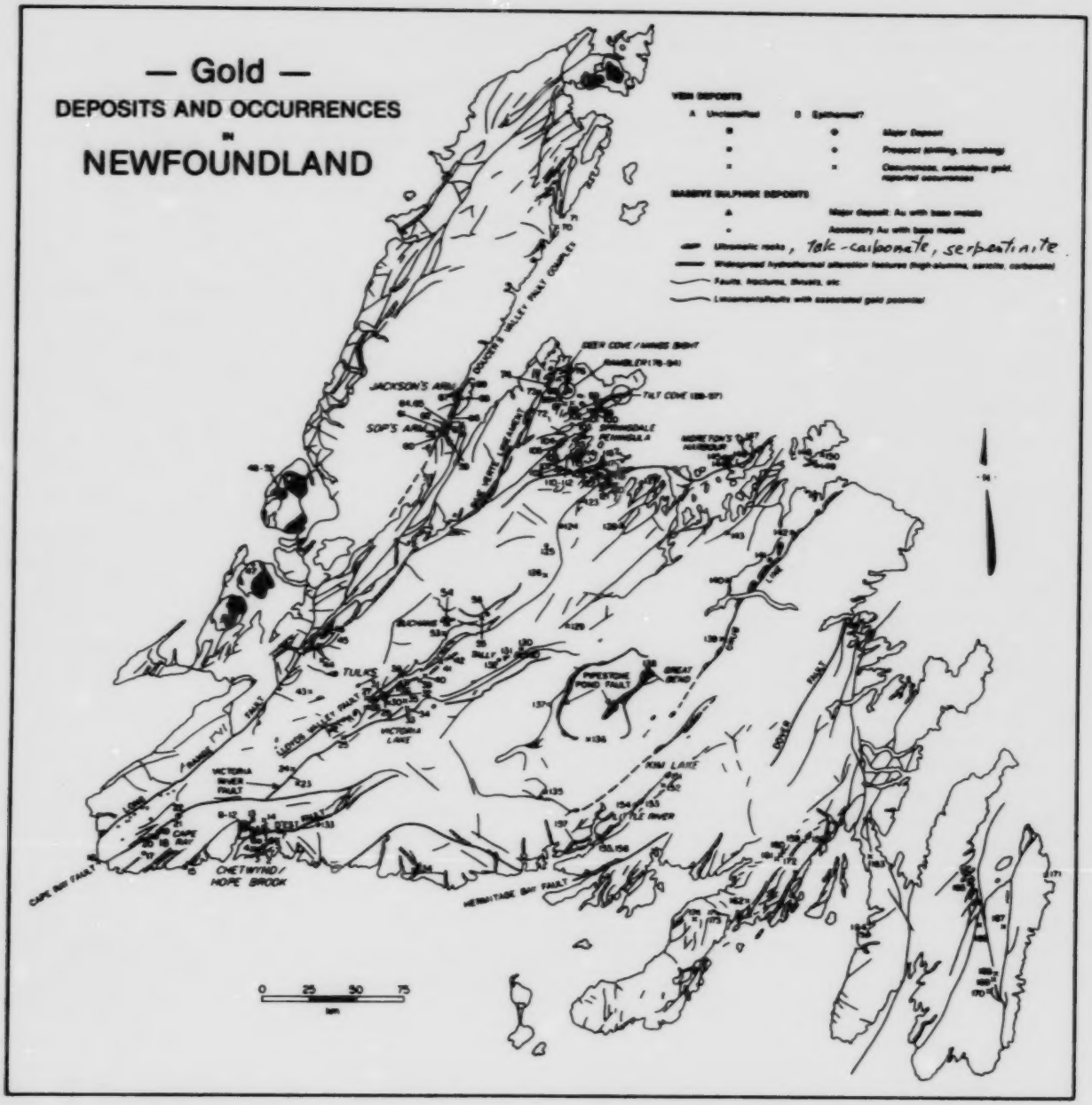


**Figure 1:** Gold deposits and ocurrences in Newfoundland.

**Table 1: Examples of listings of gold occurrences in Newfoundland (see Open File Nfld. 1510 for complete listing).**

**1 Hope Brook Mine**
110/09/Pyr018, Au003

Reserves: 11.2 mt at 4.54 g/t Au.

Deposit in silicified rocks (400.0 by 50.0 m) in 5.0 by 0.4 km altered silicified - pyrophyllitized zone. In felsic volcanic rocks of the Ordovician(?) La Poile Group. Epithermal-style mineralization.

MacKenzie C.B., 1986: Geology and mineralization of the Chetwynd deposit, southeastern Newfoundland, Canada. In Proceedings of Gold 86, an international symposium on the geology of gold. MacDonald, A.J. (ed.). Toronto 1986, p. 137-148.

**58 Silver Mountain**
12H/11

Gold occurrences in shear zone within the Late Grenvillian Main River granite.

D. MacInnes, Noranda Exploration, 1987: Personal communication.

**138 Chioux Brook/Great Bend**
2D/11/Au001

Float: to 20.6 g/t Au. Outcrop grab: 109.0 g/t Au. 2 DDH: 3.76 g/t Au over 2.4 m and 3.42 g/t Au over 1.2 m.

Outcrop also has 2.4% As and 47.0 ppm Sb. Pyrite - arsenopyrite-rich, brecciated, ophiolitic diabase and serpentinite of the Ordovician Pipestone Pond Complex.

Zwicker, E. and Strong, D.F., 1986: GSC - Report 80-1A, p. 393-397.
Murphy, Lew, 1986: NDM - Publications and Information Section, File 335.09.

**148 Change Islands**
2E/09

3 grabs: 1.5 to 164.1 g/t Au with 43.0 to 121.0 g/t Ag.

Quartz vein 0.05 to 0.3 m wide and 10.0 to 12.0 m long. In felsic dike cutting felsic pyroclastics of the Silurian Indian Islands Group. Also 0.29 to 1.36% Cu, 0.76 to 3.48% Pb and 0.47 to 2.81% Zn.

MacGillivray, G., 1985: NDM - [2E/09(537)].
MacGillivray, G., 1987: Personal communication.

# Marble Assessment Project - 1987

by

A.F. Howse
Mineral Deposits Section

The 1987 field season concluded an assessment study of Newfoundland's marble resource. The aim of the project was to determine potential value of the resource for such industrial applications as fillers, whiteners and dimension stone. The project began in 1985 with a survey that included extensive sampling of high purity marble deposits in western Newfoundland. This work identified several promising marble prospects, one of which, the Penny's Pond deposit near Roddickton was selected for follow-up work that included diamond drilling. This drilling outlined significant reserves of high purity marble at Penny's Pond and Coles Pond near Roddickton (Howse, 1987).

The 1987 work includes an assessment of the chemical and physical data which resulted from the analyses of 1201 m of drill core. Based on the results, a total reserve of approximately 3 million tonnes of high purity white marble has been proved in two deposits with excellent potential for additional reserves.

Several occurrences of grey to white marble were investigated and sampled in an area west of Croque. The marble occurs in a belt of Lower-Middle Ordovician carbonate rocks referred to as the White Arm Pond Window (Smyth, 1973; Stouge, 1983) (Figure 1). The marble occurs in thin zones, generally less than 20 m wide, is invariably associated with dolomite, has a fine to medium grained texture and displays varying degrees of whiteness and purity.

A belt of recrystallized dolomite and limestone, south of Pinchgut Lake near Corner Brook, was also investigated and sampled.

## DRILLING RESULTS

### Penny's Pond Deposit

The Penny's Pond marble deposit is exposed immediately north and south of the Conche Highway (Route 433). It strikes approximately north-south and dips 45 to 50° eastward. The marble was traced 450 m southward from Penny's Pond in 11 drillholes spaced at 40 m intervals returning AQ size core. Based on geochemical analyses and dry brightness tests carried out on drill core from 6 of 11 holes, the northern half of this zone is estimated to contain over 1.8 million tonnes of high purity white marble (Table I). The remaining 5 holes were not tested for dry brightness, but, geochemical analyses and the appearance of the core strongly indicate substantial additional reserves.

### Coles Pond Deposit

The Coles Pond deposit was discovered during the 1986 marble assessment program and was tested by diamond drilling. The marble is exposed along woods roads about 8 km north of the Conche Highway. It overlies dolomitic marble and limestone in a northeast trending asymmetric syncline, which has a steeply dipping east limb and a more

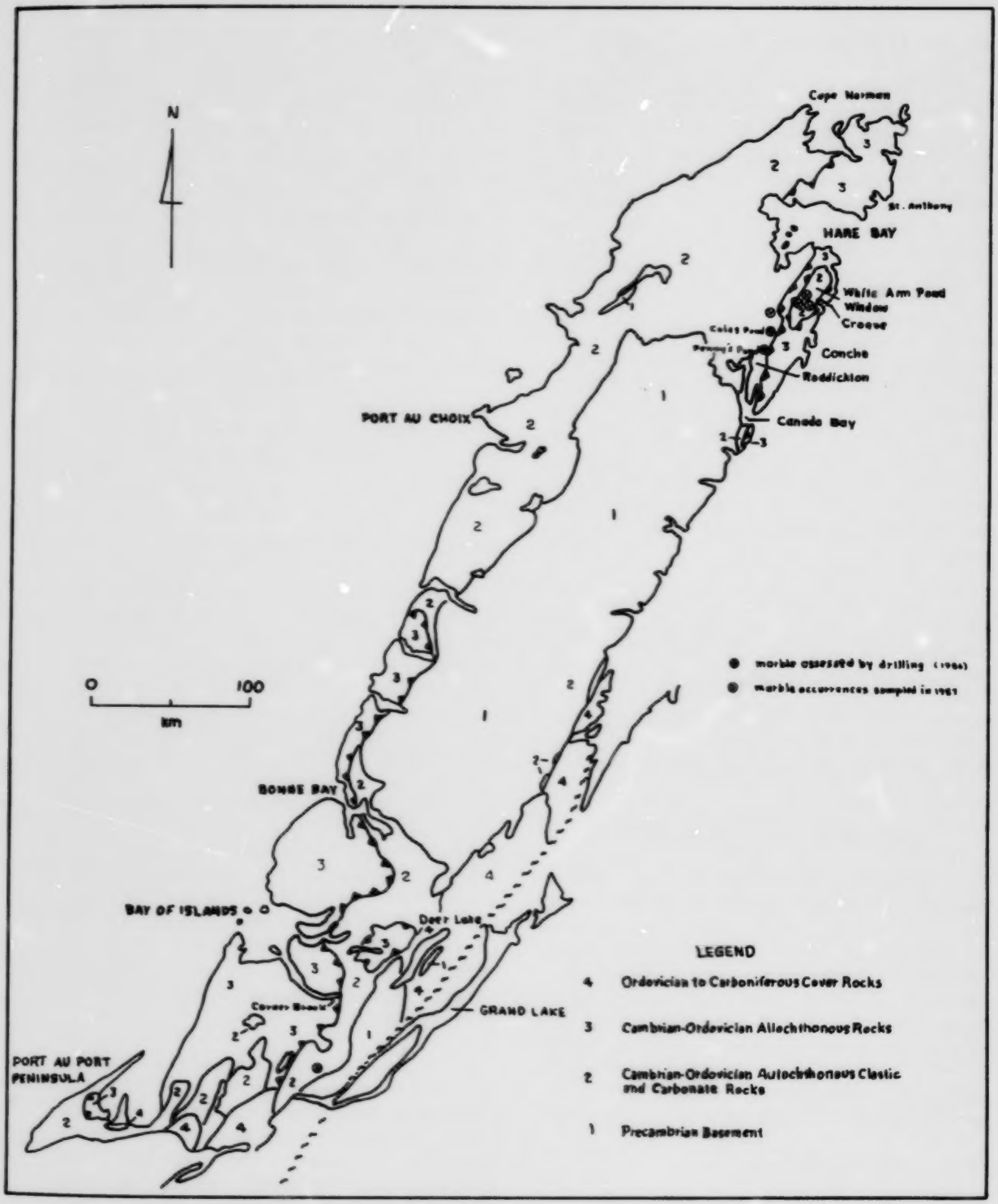


**Figure 1:** Geological elements of Newfoundland's west coast showing locations of marble prospects and occurrences investigated in 1987.

gently dipping west limb. Topographically, the west limb is expressed as a northeast trending ridge. Because of its obvious potential as a quarry site it was decided to test the ridge by diamond drilling. Eight holes of 45 m average depth and inclined at 60° were spaced at 40 m intervals along the base of the ridge and drilled in a northwesterly direction normal to the trend of the zone.

The results of the drilling confirm the presence of significant reserves of high purity white marble having a high degree of brightness. Based on the analyses of drill core from 6 of the 8 holes the deposit is estimated to contain 1.2 million tonnes. Tonnage was calculated to a maximum depth of 30 m and the potential for additional reserves is excellent.

The Department of Mines is currently inviting proposals for development, production and marketing of the marble which, because of its high quality, is suitable as a mineral filler. Mineral fillers are used in a wide variety of products, including paper, paints and plastics.

## CROQUE MARBLE OCCURRENCES

Several occurrences of white marble occur northeast of Coles Pond in an area of carbonate rocks referred to as the White Arm Pond Window. Limestone and dolostone within the White Arm Pond Window have been recrystallized into fine grained white to grey marbles. Several such marble zones were investigated and sampled, the most significant of which are described below:

### Powerline occurrence

A 20-m-wide zone of white to off-white marble is exposed near the power transmission line to Croque at the eastern margin of the White Arm Pond Window. The marble has a light brown weathered surface, is fine grained, and strongly cleaved (050/40SE). Bands of mica rich impurities 30 to 40 cm wide are found within the marble. The marble zone is underlain and overlain by thin bedded recrystallized dolomite containing chert and numerous narrow quartz veins. The marble is part of a northeast trending easterly dipping sequence of dolomite, marble and limestone which on the north side of the Croque access road, is exposed almost continuously for about 150 m. With the exception of the marble described, most of the bands within the sequence are less than 10 m wide, and intimately associated with dolomite.

### Skidder Trail occurrence

White marble is exposed in several locations near the western boundary of the White Arm Pond Window. It is found along logging trails and in outcrop along a ridge southwest of the Croque Road where it can be traced along strike for approximately 600 m. The marble bands are less than 8 m wide and are invariably and intimately associated with dolomite. The marble is fine grained and somewhat chalky in places. Thin, silty laminations (mm scale) are found in some of the marble bands and these appear to be aligned along the cleavage that is strongly developed in a northeast direction and dipping steeply (70 to 80°) south.

A zone of greyish-white marble and dolomite was investigated along a northeast trending zone which extends north of the Croque Road for several hundred metres. The marble is sporadically exposed along a low ridge and along logging roads. The widest band of marble was observed 2.7 km north of the Croque Road. The marble is very fine grained, has an off-white colour with a brown tint.

It is strongly cleaved (020/65E) and tends to break easily into slabs. Impurities noted at different points along the zone include iron stains along fracture planes, a chlorite schist band (1 m wide), and thin shaley bands (cm scale). The entire marble zone is overlain and underlain by a distinctive yellowish-brown weathered dolomite. Representative samples of the marble were collected for analyses.

Tom Roses Pond occurrence

Light grey to white marble occurs along a northeast trending easterly dipping belt of carbonate rocks exposed along low ridges and bush roads immediately south of Tom Roses Pond approximately 4 km east of Route 433. The marble is predominantly grey, fine grained, and displays a strong cleavage (025/20E).

## PINCHGUT LAKE MARBLE

Narrow bands of ivory white marble and wider, more extensive zones of pink dolomite marble were noted near Pinchgut Lake south of Corner Brook. These occur in highly deformed and recrystallized carbonate rocks of the Lower Ordovician St. George Group. The white marble does not appear to be extensive; the widest sampled zone measured 8 m, has a strong subvertical cleavage trending north-south, and a fine- to medium-grained texture. Representative chip samples were collected from all significant exposures of marble and dolomite.

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# Dolomite Evaluation Project

by

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During the 1987 field season the carbonate sequences along the west coast and northern peninsula were mapped and sampled. The aim of the project was to identify deposits of metallurgical grade dolomite. The Lower Ordovician St. George Group was the major unit of interest although portions of the Petit Jardin Formation of the Upper Cambrian Port au Port Group were also examined.

Five areas were considered to have dolomite deposits with good potential for development. These are located on the Port au Port Peninsula, at Goose Arm and on the Northern Peninsula at Deer Cove, Port au Choix and Cape Norman (Figure 1).

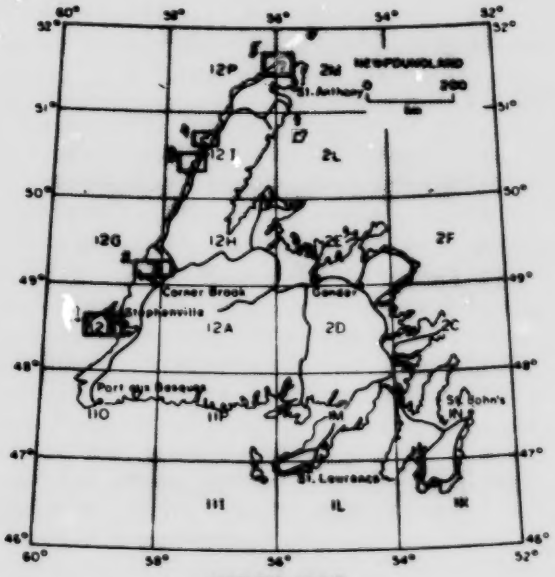


**Figure** 1: Location of major prospects: 1. Port au Port, 2. Goose Arm, 3. Deer Cove, 4. Port au Choix, 5. Cape Norman.

## Port au Port Peninsula

The Port au Port deposit occurs in the Pine Tree Unit of the St. George Group. It consists of buff to light brown, fine to medium grained, massive dolomite up to 45 m thick. Chert, the main impurity, is scattered throughout the section but is most abundant in the lower 15 m. Bedding was almost completely obliterated during the dolomitization process but a gentle northerly dip can be inferred from overlying and underlying units assumed to have a conformable contact with the Pine Tree Unit. The Pine Tree Unit forms a narrow belt trending east-west across the peninsula from the White Hills in the west, across the isthmus on the east and over a hill on the mainland. The unit is cut by numerous northeast-trending faults which break the unit into three main belts. The middle belt which extends from Lower Cove in the southwest to Piccadilly in the northeast is considered to have the best potential. The deposit is well exposed, has excellent relief for quarrying, appears to be of good quality and occurs near tidewater.

## Goose Arm

The Goose Arm area contains enormous reserves of potentially metallurgical grade dolomite in five localities within the Hughes Brook Formation of the St. George Group. The dolomite is hard, grey, fine grained, medium to thick bedded and mostly massive. Quartz veins are extensive in some areas, but in others, visible impurities are absent. The deposits are located in two fiords

and the mountainous terrane and steep cliffs provide excellent quarry sites having deep sheltered waters for the necessary development of shipping facilities.

Deer Cove

The Deer Cove area hosts a dolomite prospect within the Catoche Formation of the St. George Group. The dolomite is grey, microcrystalline, thin to medium bedded and massive. It contains no noticeable impurities. The terrain is quite flat in the vicinity; however, subhorizontal bedding and 15-20 m of relief in an embayment on the south, provides a potentially good quarry site for the 200 m wide strip which trends north along the coast for approximately 3000 m. Seasonal shipping facilities are available 40 km to the north of Hawke's Bay.

Port au Choix

Two deposits occur near Port au Choix, one east of Back Arm and the other along the northern quarter of the Point Riche Peninsula. The latter occurs within the boundaries of a national historic park and is thus improbable for development. The deposits constitute 16 to 17 m thick, lithologically-similar sections of the Catoche Formation. The host rock consists of buff or brown, fine to medium grained, medium to thick bedded dolomite and is variably mottled and vuggy. Locally the dolomite is extremely vuggy with fine and medium grained portions probably reflecting burrow textures in the original limestone. The medium grained portions have abundant intergranular space which, along with the vug space, is partly filled by black organic material. Vugs up to 1 cm in diameter in the more massive dolomite are lined by quartz or dolomite. Quartz also occurs as 1 to 4 cm fine grained masses that are more abundant in the upper levels of the sections. Hawke's Bay, 30 km to the south, has seasonal shipping facilities.

Cape Norman

An approximately 15 m thick section of gently warped Catoche Formation dolomite is located at Cape Norman at the tip of the Northern Peninsula. The dolomite is grey, fine grained, massive and thick bedded. The rock is more vuggy in the lower beds with vugs generally 1 to 2 cm in diameter but occasionally up to 20 cm. Quartz or dolomite crystals generally line these vugs. At higher stratigraphic levels impurities consist of scattered chert nodules and masses of fine grained quartz up to 3 cm in diameter. Pseudobreccia textures are developed locally. A cliff face on the western coast provides a quarry face and there is essentially no overburden. No port facilities are present in the area and ice conditions hinder shipping for much of the year.

In addition to the major dolomite prospects described here several other occurrences were investigated and sampled during the project. Over 370 samples were collected and are being analyzed for a range of elements at the Department of Mines geochemistry laboratory.

# Metallogeny of peralkaline rocks in Labrador: Strange Lake peralkaline granite and Letitia Lake showings

by

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Mineral Deposits Section

## Introduction

The study of rare-metal showings/deposits (Zr, Be, Nb, Y, Ta, REE) within the Strange Lake peralkaline granite and the Red Wine intrusive suite has been ongoing since 1984. The program for 1986-1987 included the study of thin sections, the manipulation and interpretation of whole rock geochemical data and the preparation of mineral separates for mineral analysis. Final reports for the metallogeny of the Strange Lake deposit and the Letitia Lake showings are scheduled to be completed in early 1989.

The Letitia Lake showings (e.g. Mann #1) and related peralkaline rocks are located in central Labrador, 290 km east-southeast of Schefferville, Quebec and 160 km northwest of Goose Bay, Labrador (Figure 1; NTS 13L/1). The Strange Lake deposit and its host peralkaline granite are located in northern Labrador (on the Quebec-Labrador border), 150 km west of the coastal village of Nain and 250 km northwest of Schefferville (Figure 1; NTS 24A/8).

## Strange Lake Peralkaline Granite

Research carried out during the past year has focused on separating minerals from the high grade mineralization, petrographic study and the procurement of whole rock analyses for a wide range of elements. The compilation of chemical and other data from similar peralkaline-hosted rare-metal deposits throughout the world, as discussed in a previous

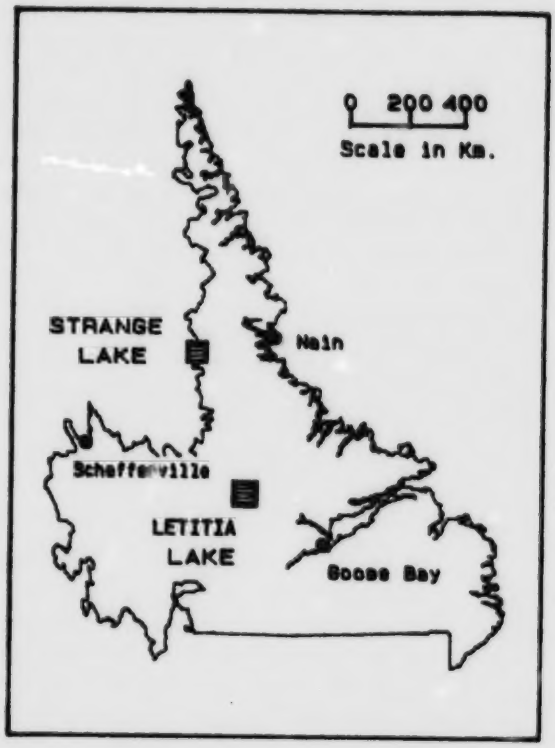


**Figure 1. Location of the Letitia Lake and Strange Lake areas.**

Report of Activities (Miller, 1986a) has also been continued.

The mineral separation program has obtained several heavy mineral separates from 6 petrographically distinct phases from within the high grade mineralization (exotic-rich phase; Miller 1986b). Preliminary observations indicate that clean amphibole, pyroxene, and thorite separates are possible after the magnetic and hand-picking separation steps have been completed. If high quality separates can be obtained then it is planned to use neutron

activation and other small sample techniques to obtain analyses for rare metals and other elements in these minerals.

Petrographic studies have been used to further refine the mineralogical-textural classification for the Strange Lake granite (Miller, 1986b) and to characterize these unusual rocks. An important part of this phase of study will be the documentation of the unusual textures and minerals. Many of the unusual minerals found at Strange Lake (e.g. gittinsite and gagarinite) are ore minerals.

Literature research has been focusing on the compilation of data, particularly geochemical data, from similar rare-metal deposits and peralkaline rocks. This work has been supplemented with a field trip to the Thor Lake deposit (N.W.T.), which is a peralkaline-hosted rare-metal deposit that has the potential to produce Be, Nd, Y and REE. Some geochemical and geological features of the Thor Lake deposit are similar to those of the Strange Lake deposit. Thus, a comparison of these two deposits will be valuable in refining exploration strategies and petrogenetic models for rare-metal deposits.

Work in the coming year will be concentrated on producing a final report for the Strange Lake project which will include: 1) a description of the deposit and peralkaline granite, 2) a petrogenetic model, and 3) an exploration strategy for similar deposits.

Mann-type Deposits in the Letitia Lake area

The study of the Mann-type rare-metal deposits, during the past year, has focused on the geochemistry of these deposits and the associated peralkaline rocks and the field relationship between these showings and nearby rocks. This work has led to the discovery of Y-rich zones in some of these showings; these showings had previously been described as Nb-Be-LREE showings.

Continuation of the study of the relationship between the rare-metal showings and associated rocks (Miller, 1987) has resulted in the placement of the Mann-type showings, within the local stratigraphy, at or near the contact of the rocks formed by the last phases of magmatic activity within the Letitia Lake Group. This work also indicates that many of the showings occur within peralkaline trachytic volcanic flows and pyroclastics and as veins located in subvolcanic syenites. These conclusions provide a clear-cut exploration target within a small stratigraphic interval of the Letitia Lake Group. There are several showings that occur within this exploration target that have not been adequately evaluated for rare-metal mineralization; these showings are presently open for staking.

The geochemical program for the Mann-type showings has resulted in the discovery of high values of Y (up to 0.30 percent Y203) within boulders and outcrop in the Two Tom Lake area (Batterson and Miller, 1987). High values of Y have not been previously reported from other Mann-type showings in the vicinity. This discovery greatly increases the economic potential of this type of showing.

The final phase of this study of the Mann-type deposits will deal mainly with the preparation of the final report. The report will include the deposit type-description, a petrogenetic model and an exploration strategy. Geochemical work will be also undertaken to ascertain whether or not Y mineralization is associated with any of the other known Mann-type showings.

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# Geology of the area west of New Bay Pond, Notre Dame Bay, and redefinition of the "Frozen Ocean Group"

by

H.S. Swinden
Geological Survey of Canada

The 1987 field season was the third in the project "Metallogeny of the Buchans - Robert's Arm Belt". Previous mapping was concentrated in the Robert's Arm and Buchans groups (Swinden and Sacks, 1986; Swinden, 1987). The present mapping was intended to document the geology of the Frozen Ocean Group (Dean, 1978) which has generally been correlated with the Buchans - Robert's Arm Belt (e.g. Dean and Strong, 1976) on the basis of lithological similarity of the mafic volcanic rocks. Although the Frozen Ocean Group is shown on most regional maps as dominantly mafic volcanic rocks (e.g. Dean 1978; Kean et al., 1981), mapping by exploration company geologists in the late 1970's and early 1980's (Fenton, 1981) showed that both mafic and felsic volcanic rocks as well as sedimentary rocks were represented and provided the impetus to carry out the mapping reported here.

The present mapping shows that the Frozen Ocean Group, as it is presently defined, is composite, consisting of two distinct lithostratigraphic units (Figure 1). These are apparently separated by an arm of the Hodges Hill intrusive suite which extends from the southern end of Frozen Ocean Lake to the south end of New Bay Pond. For convenience, in the following discussion, these are termed the "New Bay Pond sequence" and the "Charles Lake sequence" n the north and south respectively (Figure 1).

The New Bay Pond sequence. The New Bay Pond sequence consists of approximately 65 percent mafic volcanic rocks and 35 percent epiclastic rocks. Stratified rocks strike dominantly northwest and face northeast, although with local reversals in facing direction due to folding. Mafic volcanic rocks that make up the lower and upper stratigraphic units of this sequence, consist mainly of pillow breccia and hyaloclastite. This consists of generally unsorted, angular to subrounded, fragments of vesicular pillow lava in a fine grained, chloritic matrix which was probably originally a mixture of fine grained tuff and volcanic glass. Lesser pillow lava are present, particularly near the top of the sequence. There is an intermediate unit of epiclastic rocks, dominantly turbiditic greywacke with lesser polymictic conglomerate and minor argillite. Contrary to exploration company maps, there does not seem to be a major felsic volcanic centre developed in the lower volcanic unit immediately west of New Bay Pond.

The southern and western contacts of this sequence are intruded by granites and lesser mafic plutonic rocks of the Hodges Hill intrusive suite. Good intrusive breccias are developed in both areas. The western contact is under New Bay Pond. The northern contact is a northwest-striking fault, exposed on the road near the north end of New Bay Pond, and brings the sequence against Caradocian black shale.

The Charles Lake sequence. The Charles Lake sequence consists of a northeast-striking volcanic assemblage that is lithologically very

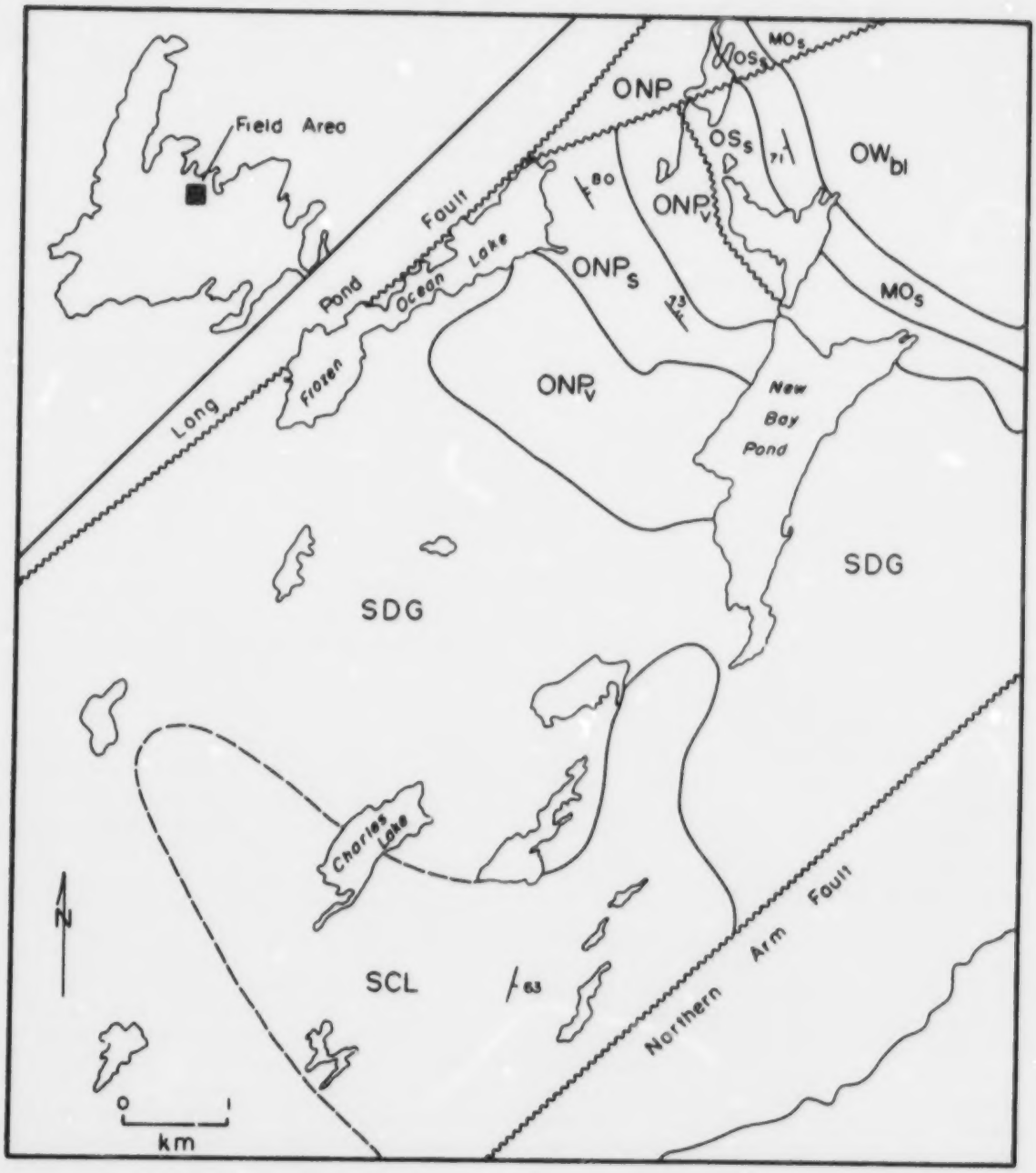


**Figure 1:** Simplified geology of the area west of New Bay Pond.

Strike and dip (top known)

Strike and dip (top unknown)

Fault

Geological contact (defined, approximate)

LEGEND

SILURIAN OR DEVONIAN

SDG Plutonic rocks; include granite, granodiorite, diorite and gabbro

SILURIAN

SCL Charles Lake sequence: red to orange rhyolite, rhyolitic ash-flow tuff, massive intermediate to mafic volcanic rocks

UPPER ORDOVICIAN TO SILURIAN

OSs Sanson Greywackes: volcanically derived turbiditic greywacke, lesser argillite

MIDDLE ORDOVICIAN AND EARLIER

MOs Shoal Arm Formation: carbonaceous shale, chert

OWbl Wild Bight Group (Big Lewis Lake volcanics): dominantly pillow breccia, lesser pillow lava, epiclastic rocks

ONP New Bay Pond sequence: ONPv, dominantly pillow breccia, lesser pillow lava; ONPs, epiclastic turbiditic greywacke, lesser polymictic conglomerate, minor argillite

different from the New Bay Pond sequence. The dominant lithologies are red to orange silicic volcanic rocks and massive pale- to dark-green mafic volcanic rocks. They appear to be present in roughly equal amounts, although outcrop is not sufficiently good to accurately estimate the proportions. The felsic volcanic rocks include ash-flow crystal tuff, locally with well developed lithophysae, massive fine grained rhyolite porphyry and rheoignimbrite. There are no sedimentary rocks and no evidence of marine environments. The rocks are characteristic of Silurian, subaerial environments elsewhere in central Newfoundland and similar lithological assemblages can be found in the Botwood and Springdale groups.

Regional correlations and economic implications: The two lithostratigraphic sequences in this area clearly represent very different physical and magmatic environments and should not be included together in the same group. The New Bay Pond sequence is lithologically very similar to volcanic rocks at the top of the Ordovician Wild Bight Group to the immediate northwest, termed the "Big Lewis Lake basalts" by Swinden (1984), particularly with respect to the large volumes of hyaloclastite in the mafic volcanic units. These rocks are interpreted to be Ordovician and probably should be included in the Wild Bight Group. The Charles Lake sequence is probably Silurian. It is not in stratigraphic continuity with any other Silurian rocks and will eventually be formally defined as a distinct formation or group.

Present mapping has implications for the economic potential of these sequences. The Big Lewis Lake basalts, with which the New Bay Pond sequence is correlated, have not metal showings and are not stratigraphically equivalent to the productive stratigraphy farther north in the Wild Bight Group (e.g. the sequences that host the Point Leamington and Lockport massive sulphide deposits). It is tentatively concluded that these rocks do not have a high potential for further discoveries of massive sulphides. The recognition that the Charles Lake sequence is probably Silurian raises the possibility that epithermal systems similar to those of similar age in White Bay (Tuach, 1987) may be present, although no evidence of this was seen during the present mapping.

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## Metallogenic Studies - Central Newfoundland

by

B.F. Kean
Mineral Deposits Section

This project is now in the office stage except for minor follow-up field work. The final report on the Lushs Bight Group is near completion and apreliminary version of the maps are on "Open File". The main thrust of the Victoria Lake Group component of this project during the past year has been toward completion of the geochemistry of the various mafic volcanic units and in the preparation of a regional metallogenic map for the pre-Middle Ordovician rocks of central Newfoundland in conjunction with the Geological Survey of Canada. The mafic volcanic rocks were sampled in order to establish their paleotectonic environments and include the Tulks Hill, Tally Pond, Harmsworth Steady, Harbour Round, Pine Falls, Diversion Lake, Carter Lake and Lemottes Lake volcanics. The geological compilation involves updating existing 1:50,000 scale maps, age dating, paleotological studies and the study of various mineral deposits including massive sulphides and gold mineralization. Affiliated with this project is a detailed examination of the Midas Pond gold prospect as part of a M.Sc study by David Evans.

This project is due for completion by the end of the Canada-Newfoundland Mineral Development Agreement in 1989.

# Alteration assemblages in a gold-bearing stockwork system hosted by Late Grenvillian granitoids

by

C. M. Saunders and J. Tuach
Mineral Deposits Section

## Introduction

Significant gold mineralizaton occurs along the Cat Arm Road (Figure 1) near Jackson's Arm (Bruneu, 1984; BP-Selco-Varna, press release, June 12, 1987). Preliminary field descriptions of the geology were given by Tuach and French (1986) and Tuach (1987). The host to the mineralization and accompanying hydrothermal alteration assemblages is a Late Grenvillian megacrystic foliated granodiorite which provided zircon ages circa 1042 Ma (Erdmer, 1986).

## Petrography

### Host Rocks

The host granodiorite is composed of feldspar megacrysts set in a matrix of biotite, and locally hornblende, intergrown with abundant sphene, ilmenite and apatite and lesser zircon. Minor chlorite and epidote ateration of biotite may be present.

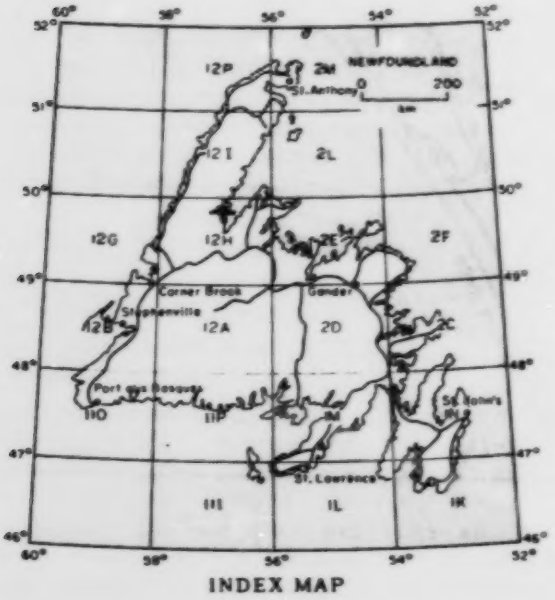


**Figure 1:** Location of study area.

The rock contains plagioclase and finely perthitic K-feldspar. The plagioclase, which is heavily sausseritized, may form megacrysts up to 2 cm long, but more commonly forms 0.5 cm anhedral grains. The K-feldspar, which commonly exhibits fine-scale microcline twinning, predominantly occurs as recrystallized. Relict patches of plagioclase occur within the microcline suggesting that it formed by replacement of original plagioclase megacrysts. The proportion of microcline increases to the east where it is most abundant in the vicinity of mineralization.

Hornblende is present in several of the most westerly samples (Figure 2) where it is partly replaced by biotite, which in turn is partly replaced by chlorite and epidote. The distribution of these mineral assemblages indicates a retrogressive metamorphic event that is more highly developed in the east, in agreement with rgional metamorphic patterns described by Erdmer (1986).

## Hydrothermal Alteration Assemblages

Mineralization was accompanied by the development of hydrothermal alteration assemblages which postdate the regional Grenvillian foliation of the granodiorite. There is a high proportion of microcline in the vicinity of mineralization. Microcline and plagioclase commonly have been

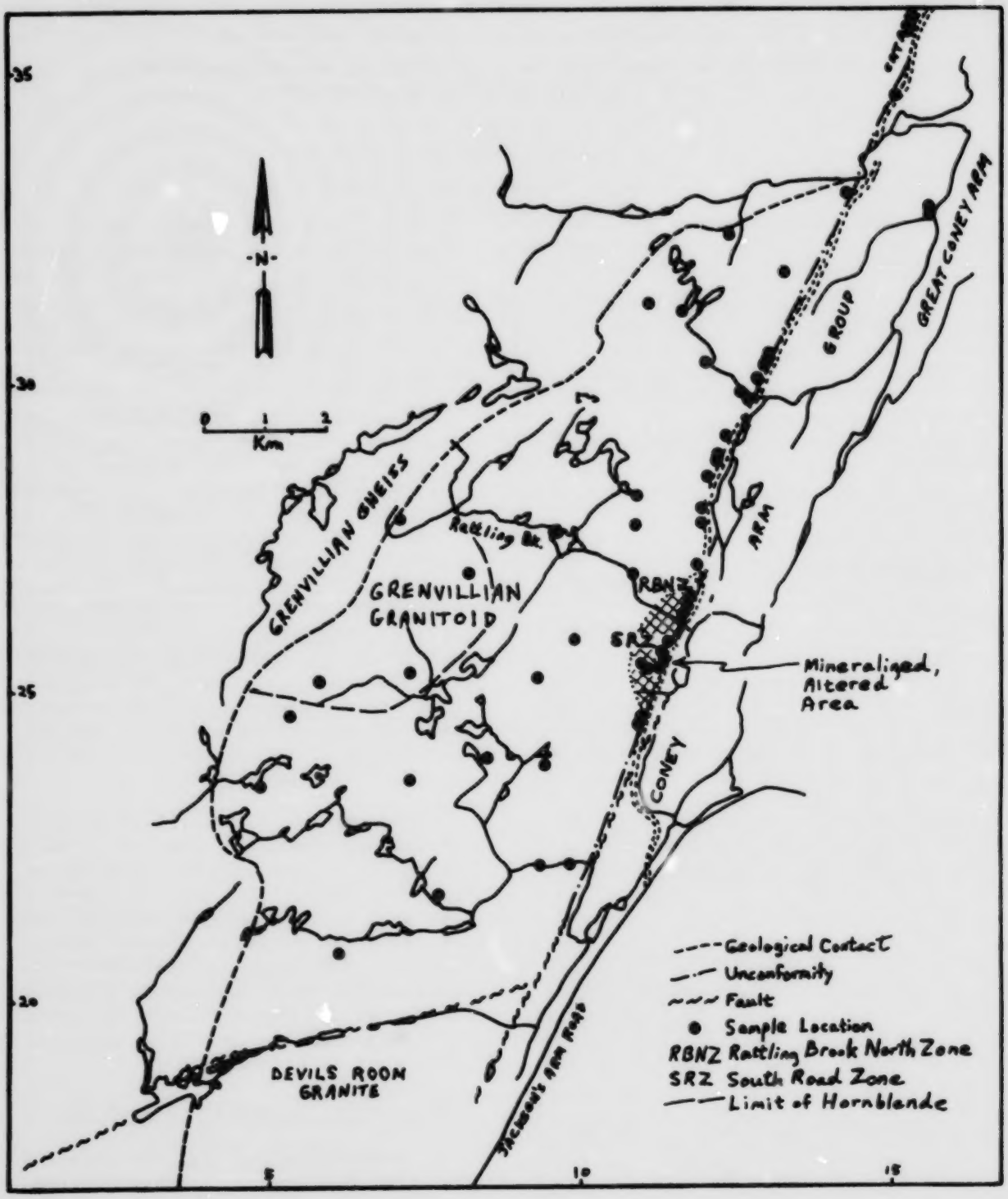


**Figure 2:** General geology and sample locations in the Jackson's Arm area. RBNZ and SRZ are gold-bearing zones. Area with stockwork fractures and relatively abundant hydrothermal alteration assemblages is cross-hatched.

extensively recrystallized. Outlines of original megacrysts are locally preserved but the megacrysts are internally recrystallized and are composed of uniform grains characterized by sharp boundaries and well developed triple point junctions.

The recrystallized microcline and plagioclase are overprinted by a later microcrystalline albite-quartz-Fe carbonate-sericite assemblage that occurs in fractures and breccias. Based on field observations, Tuach and French (1986) misidentified the microcrystalline albite-quarz as fine grained silica. The alteration assemblage locally becomes pervasive over a distance of several centimetres marginal to fractures. Albite preferentially replaces microcline along rims and fractures, but as albitization becomes more pervasive entire microcline megacrysts have been replaced.

Sericite replaces biotite, chlorite and epidote. Ilmenite is replaced by rutile, and sphene breaks down to rutile and calcite. The zircon and apatite resisted alteration and are residual. Pyrite, and to a lesser extent arsenopyrite, partly replace the titanium oxides. An assemblage of finely intergrown pyrite (+/- arsenopyrite), sericite, calcite, rutile/leucoxene, apatite and zircon is present in the most altered samples.

## Sulphide Mineral Assemblage

The albite - quartz - Fe-carbonate - sericite assemblage is accompanied by 10 percent sulphides consisting predominantly of pyrite and arsenopyrite, along with rare chalcopyrite. Pyrrhotite and galena occur as inclusions in pyrite and arsenopyrite. Gold grains were observed in two thin sections as 1 to 15 micron inclusions in pyrite, but were not observed in arsenopyrite. The gold commonly occurs as clusters of several grains. SEM analyses show the gold contains only traces of silver. Rare, extremely fine grained ( 1 micron) Au, Ag telluride, Pb, Au telluride and Pb telluride were observed as inclusions in pyrite in one thin-section.

The sulphides occur in veinlets and as disseminations of fine grained euhedral crystals. Pyrite crystals are commonly arranged along the foliation of the host rock, but are completely undeformed. The tendency of pyrite to replace deformed titanium oxides accounts for its concentration along the foliation. Arsenopyrite forms delicate euhedral undeformed crystals which commonly have hollow cores.

## Discussion

Mineralization is clearly associated with the albite - quartz - Fe-carbonate - sericite assemblage that developed as fluids migrated along the stockwork fracture system. The temporal relationship of the microcline to the mineralized fracture system is uncertain although microcline is spatially associated with areas of mineralization. Recrystallization of microcline predated albitization and mineralization, which suggests that potassic feldspathization was an earlier event. This problem is still under investigation.

The euhedral crystal outlines of the sulphides and silicates in the fractures indicate, that they formed after any significant deformation, which suggests that the bulk of the mineralization post-dated the Acadian orogeny.

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REGIONAL GEOLOGY - LABRADOR

# Regional geological mapping, Goose - Pinus rivers area, Labrador, (13F/SW)

by

R.J. Wardle, B. Kjarsgaard, L. Crisby, C. Anstey, M. Harris and B. Lawlor
Labrador Mapping Section

The area mapped during the 1987 field season (Figure 1) lies in the interior Grenville Province of southern Labrador where it adjoins ground covered during previous work (Wardle and Ash, 1986; Wardle and Crisby, 1987) in the Goose Bay area.

The greater part of the area is underlain by monotonous, migmatitic metasedimentary gneisses typical of those which underly most of the Grenville Province in central and western Labrador. Two principal varieties are recognized: grey quartzofeldspathic gneiss deficient in sillimanite (Unit 1a), and pink, sillimanite-rich pelitic gneiss (Unit 1b). Augen gneiss (Unit 1c) is locally developed within Unit 1a. Associated with the metasedimentary gneisses are numerous small intercalations of banded (supracrustal?) amphibolite, and scarce calc silicate. Two areas of amphibolite - mafic granulite (Unit 2) probably represent recrystallized mafic plutons.

In the northeastern part of the area the metasedimentary gneisses are structurally underlain by grey, quartz diorite gneiss (Unit 3) and tonalite - granodiorite gneiss (Unit 4) broadly correlative with the extensive Susan River quartz diorite and Groswater Bay terrane gneisses which lie respectively to the north and northeast.

The metasedimentary gneisses have also been intruded by foliated megacrystic granitoid plutons of lenticular to sheet-like form (Unit 5). The northernmost pluton emmanates from the circa 1650 Ma Trans-Labrador batholith (to the north of the area) and may be of similar age.

In the southeastern portion of the map area the metasedimentary gneisses are in contact with pink granitic gneisses and amphibolites of the Lower Brook metamorphic suite (Unit 7), proposed by Wardle and Crisby (1987) to represent the strongly metamorphosed northern margin of the Mealy Mountains intrusive suite. Less deformed equivalents of this intrusive suite are seen as weakly foliated monzonites and monzodiorites exposed southeast of the Churchill River (Unit 6). The contact of the Lower Brook suite and the metasedimentary gneisses is generally sharp and marked by localized ductile shearing.

The structure of the map area is dominated by an overturned, southwest-plunging synform, located in metasedimentary gneiss but also controlling the regional distribution of megacrystic granitoid and Lower Brook suite gneisses. This structure has been openly folded by late east - west and north - south-trending folds which have locally combined to produce dome and basin interference patterns.

Regional metamorphic assemblages attest to upper amphibolite facies conditions; however, mafic units within metasedimentary gneiss preserve evidence of a granulite facies event. Several of the major shear zones also appear to have developed under granulite facies conditions.

Posttectonic rocks (Unit 8) in the area are represented by poorly

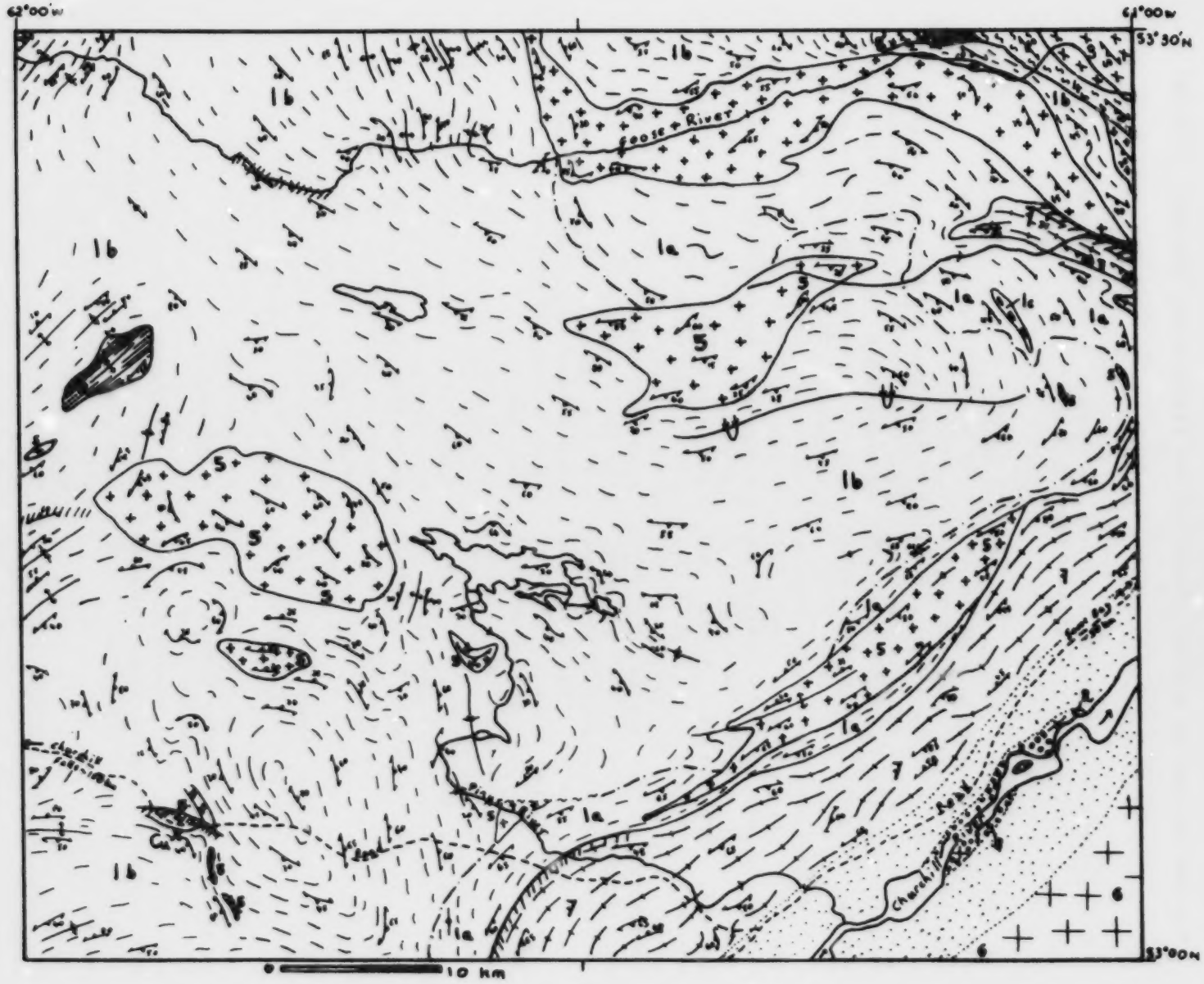
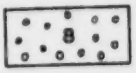


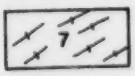

**Figure 1:** Geology of the Goose - Pinus rivers area, Labrador (13F/3,4,5 and 6)

LEGEND

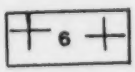
PLEISTOCENE
Fluvioglacial sand and clay



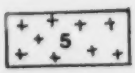

LATE PROTEROZOIC-EARLY PALEOZOIC
Cobble-boulder quartzite conglomerate and red sandstone - Double Mer Formation



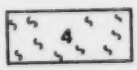

MIDDLE-LOWER PROTEROZOIC
Pink to grey granitic gneiss, and amphibolite - Lower Brook metamorphic suite



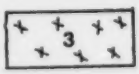

Monzonite and monzodiorite; weakly foliated - Mealy Mountains intrusive suite




K-feldspar megacrystic granitoid; foliated to gneissic



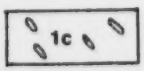

Grey, migmatitic quartz-feldspar-biotite granitoid gneiss



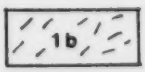

Grey, quartz-feldspar-biotite-hornblende-garnet quartz diorite gneiss - Susan River quartz diorite

Amphibolite - mafic granulite

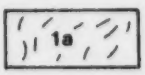
Metasedimentary gneisses




Quartz-feldspar-biotite augen gneiss




Pink, quartz-feldspar-biotite-garnet-sillimanite gneiss; sillimanite rich




Grey, quartz-feldspar-biotite-garnet gneiss; local sillimanite

Ductile shear zone

Gradational contact

exposed cobble to boulder conglomerate and sandstone preserved in what is probably a graben or half-graben along the Churchill River valley. The conglomerates are composed almost exclusively of recrystallized, fine grained, white quartzite clasts which may have derived from Middle Proterozoic supracrustal sequences such as the Seal Lake or Wakeham Bay groups.

Mineralization in the area is restricted to a small occurrence of chalcopyrite associated with calc silicate in the southwestern part of the area, and small concentrations of illmenite within metasedimentary gneiss.

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# An investigation of the margin of the Lac Joseph Allochthon

by

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Labrador Mapping Section

## Introduction

Southwestern Labrador has been subdivided into autochthonous, parautochthonous and allochthonous terranes (Rivers and Chown, 1986). Work during the 1987 field season concentrated on examining the boundary zone between the proposed Lac Joseph Allochthon and the adjacent parautochthonous terrane and to compare lithologies and the structural and metamorphic histories within each terrane. Four areas (labeled A to D in Figure 1) were selected along the boundary where the exposure was sufficient to warrant a more detailed examination of the contact zone and the rock types on either side. Work within Area E (Figure 1) around Lac Joseph attempted to explain the diminished aeromagnetic signature in the central part of the Lac Joseph Allochthon.

## Results

### Area A: Wabush - Ross Bay Junction

The parautochthon in this area is typified by the Attikamagen Formation (lower Knob Lake Group), rocks of the Shabogamo Intrusive Suite and equigranular, foliated granite. The pelitic metasediments of the Attikamagen Formation contain a single leucosome; foliations trend north to northwest. Gabbroic rocks of the Shabogamo Intrusive Suite are variably deformed and typified by garnet coronas around pyroxene.

In this area the Lac Joseph Allochthon is dominated by sillimanite-bearing paragneiss which may contain two distinct melt phases; fabrics trend north to northeast.

The Attikamagen Formation along the boundary zone is mylonitized; scarce kinematic indicators (rotated feldspar and C/shear band relationships) imply that rocks to the southeast moved over rocks to the northwest. K-feldspar megacrystic granite (locally rapakivi textured) along the allochthon - parautochthon boundary is highly strained but does not show clear mylonitic fabrics.

### Area B: Panchia Lake Area

Highly strained rocks within Ossokmanuan Lake define a north-south zone between: 1) a sillimanite-bearing paragneiss terrane with subordinate amounts of megacrystic granite to the west and 2) a predominantly intrusive terrane comprising granite, granitic orthogneiss and gabbronorite to the east. The gneisses on either side of the high-strain zone appear to have experienced a similar tectonometamorphic history.

### Area C: Map Sheets 23H/5, 6, 11, 12 and 23G/8 and 9

The southern part of this area comprises primarily gabbronorite and gabbro with subordinate amounts of sillimanite-bearing paragneiss. Paragneiss within the southeast part of the map area is typical of the unit where it is exposed elsewhere within the Lac Joseph Allochthon. In contrast, outcrops located along the northern boundary of the allochthon are strongly mylonitized. The mylonitic fabric is cross-cut by dykes of gabbronorite.

The northern part of Area C is underlain by Shabogamo gabbro and

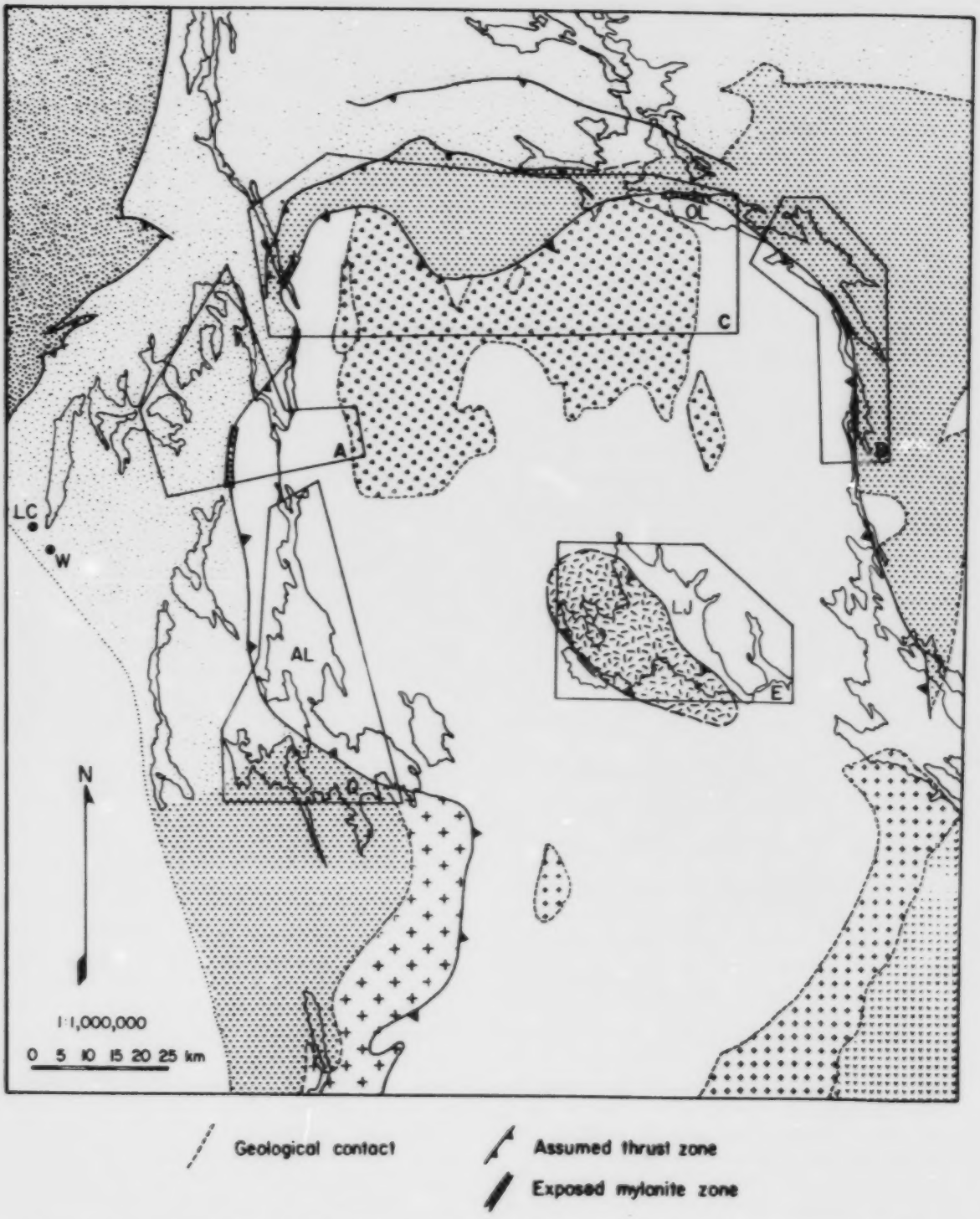



**Figure 1:** Map showing simplified geology of southwestern Labrador and location of map areas labeled A - E. AL - Ashuanipi Lake; LC - Labrador City; LJ - Lac Joseph; OL - Ossokmanuan Lake; W - Wabush.

## LEGEND

### AUTOCHTHON AND PARAUTOCHTHON

granite; equiqranular, foliated pink granite

Shabogamo Intrusive Suite; partially recrystallized and foliated gabbro with garnet corona texture

mixed granite, granodiorite, granitic orthogneiss and gabbro (including Shabogamo gabbro)

Knob Lake Group; pelitic metasediments, locally partially melted; intruded by Shabogamo gabbro and lesser amounts of granite

### LAC JOSEPH ALLOCHTHON

granite; megacrystic and rapakivi-textured granite

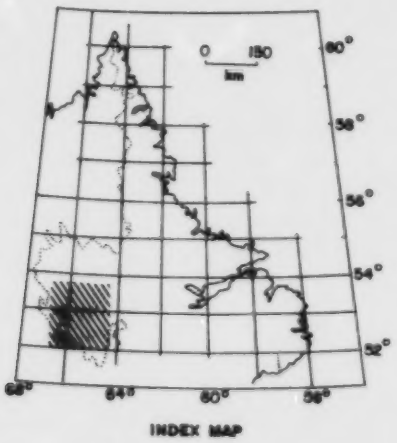
anorthosite

gabbronorite to gabbro; recrystallized, locally foliated, fine to medium grained

pelitic paragneiss; typically sillimanite-bearing restite interlayered with K-feldspar - plagioclase - quartz leucosome; interlayered with mafic gneiss and locally intruded by equigranular granite and gabbronorite

### SUPERIOR PROVINCE

undifferentiated gneisses; Ashuanipi Complex




INDEX MAP

muscovite-bearing granite, rock types typical of the parautochthonous terrane elsewhere (Connelly and Scowen, 1987).

The boundary zone between the two terranes is exposed within the eastern part of the map area in Ossokmanuan Lake where sillimanite-bearing paragneiss and Shabogamo gabbro and associated megacrystic granite are locally strongly mylonitized and tectonically intercalated.

Area D: Ashuanipi Lake

The northern part of Ashuanipi Lake is underlain by sillimanite-bearing paragneiss and a rapakivi-textured granite, both typical of the allochthon. The southern part of Area D is underlain by gabbroic rocks and the Attikamagen Formation, which has not experienced partial melting and contains chlorite and amphibole. The contrast in lithologies and metamorphic grade between the northern and southern parts of this area may indicate that an unexposed tectonic break exists within the southern part of Ashuanipi Lake.

Area E: Lac Joseph

The central part of Lac Joseph is underlain by medium grained, weakly- to moderately-deformed metagabbro to metagabbronorite that is correlated with the Shabogamo gabbro of the parautochthon. This central intrusive domain is flanked by sillimanite-bearing paragneiss that is interlayered with variable amounts of mafic gneiss; the Shabogamo gabbro does not intrude the paragneisses. The mafic gneiss contains relict orthopyroxene but is pervasively retrogressed to amphibolite grade. The occurrence of Shabogamo gabbro, a unit which to date has been found only within the parautochthon, and the presence of a high-strain zone along its contact, may imply that the central intrusive domain represents a structural window of parautochthon within the Lac Joseph Allochthon.

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# Geology of the St. Lewis River 1:100,000 Map Region, Grenville Province, eastern Labrador

by

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Labrador Mapping Section

The St. Lewis River 1:100,000 map region (13A/1,2,7,8, 3D/4,5) is located in southeast Labrador and encompasses an area of approximately 5,300 $km^2$.

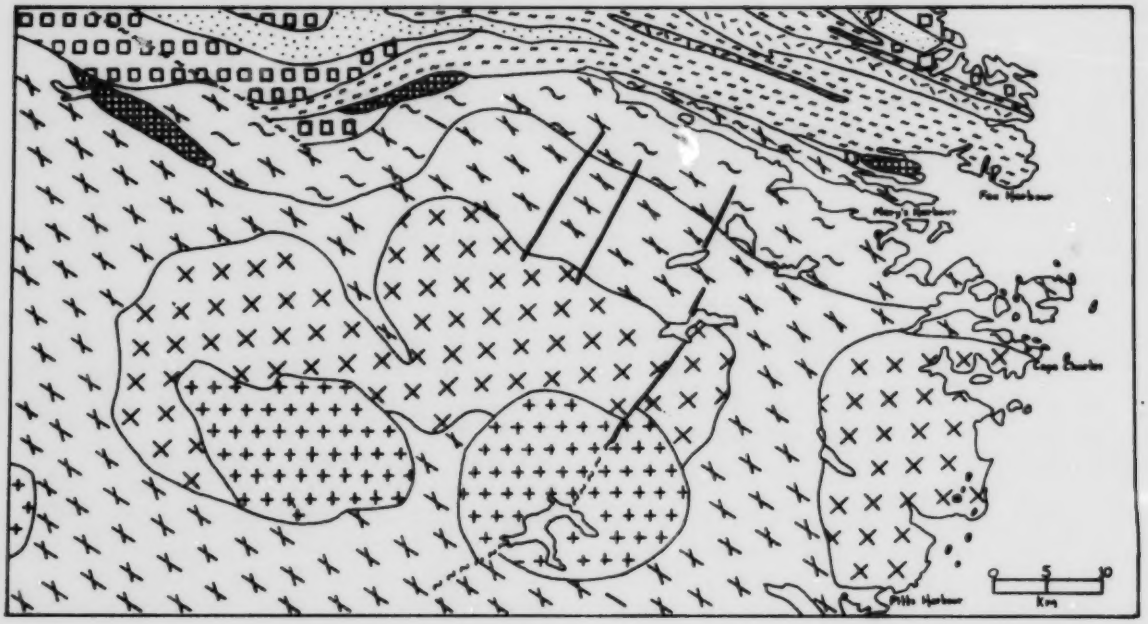
The region can be subdivided into two contrasting geological sectors, separated by a broad gradational zone having an overall east) southeast trend.

The northern part consists of interfingering, variably (but commonly intensely) deformed rocks that include sillimanite-bearing (with cordierite and/or garnet) pelitic gneiss, minor calc-silicate rocks and quartzite, associated with K-feldspar megacrystic granitoid rocks, metaanorthositic to metagabbronoritic rocks, and orthogneiss. The metaanorthositic to metagabbronoritic rocks are a continuation of the Alexis River anorthosite, previously described by Gower et al. (1985, 1987). The orthogneiss includes amphibolitic, dioritic, granodioritic, and granitic variants that represent extensively deformed and migmatized equivalents of the Alexis River anorthosite and granitoid intrusive rocks. The southern flank of the northern geological sector is dominated by intermixed, strongly foliated granites and quartzofeldspathic orthogneiss. Unlike other parts of the northern sector, orthogneiss having K-feldspar megacrysts is uncommon. Also present in the southern flank are metamorphosed mafic plutonic intrusions, probably derived from gabbro or gabbronorite protoliths.

The southern geological sector is underlain almost entirely by granitic plutonic rocks that include granite (sensu stricto), alkali-feldspar granite, monzonite and syenite (and quartz-bearing variants). Biotite is the dominant mafic mineral, but hornblende is characteristic of some units. Mafic rocks, apart from areally-restricted occurrences of amphibolite, are extremely rare. In addition to the granitoid rocks, two small outcrops of sillimanite-bearing pelitic gneiss were found in the interior part of the map region, and enigmatic, well-banded, quartzofeldspathic rocks of possible supracrustal (volcanic?) origin were mapped at coastal localities.

In Figure 1 the granitoid rocks have been subdivided into three units on the basis of foliation intensity. This subdivision is tentative and extensive modification and considerable detail can be expected after thorough evaluation of field notes and stained slabs has been made. We consider that granitoid rocks of both Labradorian and Grenvillian age are present and are separable on the basis of the presence or absence of pre-Grenvillian mafic dykes, as well as compositional, textural and deformational characteristics.

All the above units were involved in the Grenvillian Orogeny, which imparted an east-southeast structural fabric, especially in the northern geological sector. Structural trends in the southern sector are less consistently east-



LATE PRECAMBRIAN AND EARLY PHANEROZOIC

Bateau and Lighthouse Cove formations

Vein quartz

MIDDLE PROTEROZOIC (Southern sector)

Massive to weakly foliated granite

Moderately foliated granite

Strongly foliated granitoid intrusions, associated with granitic orthogneiss

MIDDLE PROTEROZOIC (Northern sector)

Intermixed granitoid intrusions and orthogneiss

Metamorphosed mafic plutonic rocks

Alexis River anorthosite

Amphibolitic, dioritic and granitic orthogneiss

K-feldspar megacrystic granitoid rocks

Pelitic metasedimentary gneiss, minor calc-silicate rocks and quartzite.

**Figure 1:** Geology of the St. Lewis River map region.

southeast, being in part, controlled by the disposition of posttectonic plutons.

Outliers of flat-lying supracrustal rocks, postdating the Grenvillian Orogeny, are present in the southeast corner of the map region. These can be correlated with the Bateau and Lighthouse Cove formations. Other post-Grenvillian rocks include vein quartz present in three major north-northeast-trending fracture systems, similarly oriented gabbroic dykes, and sporadic, unmetamorphosed, fine grained mafic dykes, without a single trend direction.

The only obvious prospects for economic mineralization are previously known muscovite-bearing pegmatites at Cape Charles and Pitts Harbour.

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# Geochemistry and mineral potential of evolved granitoid rocks and layered mafic intrusions within the Trans-Labrador batholith, eastern Labrador

by

Andrew Kerr
Labrador Mapping Section

## Introduction

This project was initiated in 1985 to assess the mineral potential of granitoid rocks in east-central Labrador, and to gain an understanding of the anatomy and petrogenesis of the Trans-Labrador batholith. Previous field work (Kerr, 1986, 1987) consisted of a lithogeochemical sampling program covering approximately twelve 1:50,000 NTS map sheets centred around the community of Makkovik (Figure 1). More detailed mapping and sampling was undertaken in areas underlain by granitoid rocks with geochemical signatures suggesting possible specialization.

The 1987 field season was limited to five weeks and completes field work for this project. There were two main objectives:

1. Follow-up sampling and mapping in possible specialized granites and syenites in the Mount Benedict - Tukialik Bay area.

2. Evaluation of the Platinum-Group Element (PGE) potential of the gabbroic rocks within the Adlavik Intrusive suite, a layered intrusion forming part of the Trans-Labrador batholith.

These are discussed under separate headings below. The general geology of the area, including major subdivisions of intrusive rocks, has been described by Gower (1981), Gower et al. (1982) and Kerr (1986, 1987) and is not discussed here.

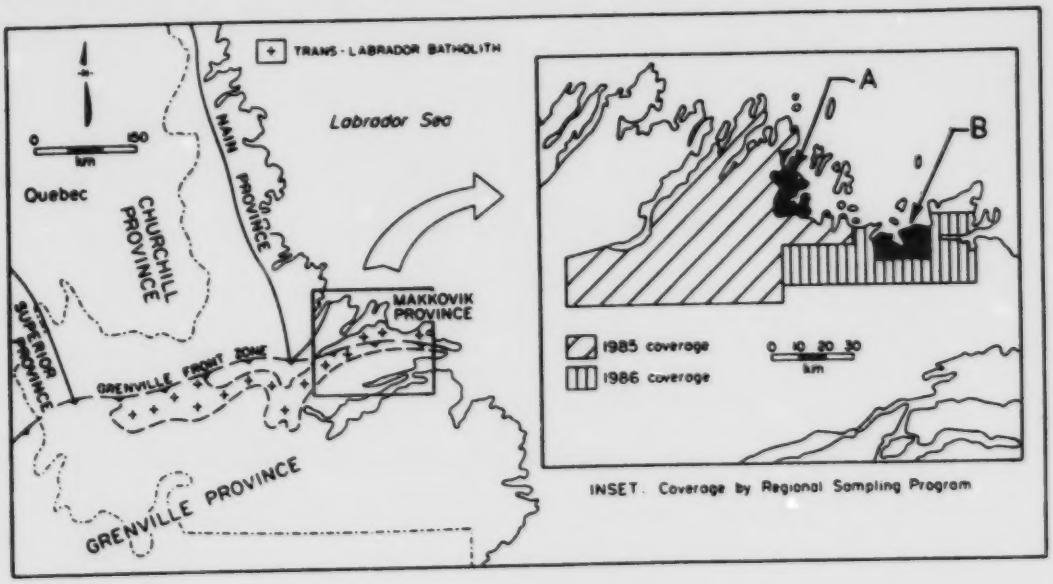


**Figure 1:** Location Map, showing coverage by regional sampling programs in the 1985 and 1986 field seasons, and areas investigated in 1987. (A) Adlavik Bay Area (B) Mount Benedict-Tukialik Bay Area.

## Granitoid Rocks of the Mount Benedict - Tukialik Bay Area

This area (Figure 1, area B) lies in the rugged terrain of the Benedict Mountains. It is underlain by two major intrusive units, referred to informally as the Mount Benedict syenite and the Tukialik granite. The former is dominated by biotite-hornblende syenite and quartz syenite. Some of the higher peaks consist of fine grained to subvolcanic material which may indicate proximity to the uppermost surface of the pluton. The Tukialik granite consists of homogeneous, coarse grained biotite granite and alkali-feldspar granite with conspicuous accessory flourite.

The regional lithogeochemistry program suggests that both units have an evolved chemistry, and the entire area shows anomalous (relative to regional abundances in the Trans-Labrador batholith) concentrations of trace elements such as Rb, Th, Be, F, Li, Zr, Ce, La and Cu. Regional lake sediment data (Kerr and Davenport, 1986) also suggest the presence of a "high" for U, Mo and F in this part of the Benedict Mountains.

Additional lithogeochemical sampling has been carried out through this area and average sample spacing decreased to approximately 1 km from the 2-km-spacing employed in the regional program. Samples will be analyzed for major and trace elements, and also for economically significant elements such as Mo, Cu, Zn, Sn, W, Sb and Ta. Data should be available in early 1988.

## Platinum-Group Element Potential of the Adlavik Intrusive Suite

The Adlavik Intrusive suite (Figure 1, area A) is a gabbro-diorite-monzonite-syenite association exposed around Adlavik Bay and on nearby islands. In view of recent interest in platinum and related elements, an evaluation of the potential of these rocks was carried out.

The Adlavik Intrusive suite was suggested by Wardle (1987) as a potential candidate for "hydrothermal" PGE mineralization associated with late-stage fluids or magmas. Pegmatitic gabbro-diorite containing minor pyrite and chalcopyrite is present in a number of outcrops and represents the most likely target of this type. The cumulate rocks in the lower part of the suite might also have potential for stratiform mineralization such as that associated with the famous Bushveld and Stillwater intrusions. It should be noted, however, that the Adlavik Intrusive suite appears to be more hydrous than typical anorogenic layered intrusions of the latter type.

Figure 2 shows the geology of the mafic portion of the Adlavik Intrusive suite and surrounding areas. Five units can be recognised, corresponding partly with previous divisions suggested by Clark (1973). The dominant rock type is a plagioclase cumulate with clinopyroxene and hornblende (mostly secondary) as mafic phases, but rocks containing primary olivine and orthopyroxene are also present. A sixth component (rarely present on a mappable scale) is formed by numerous net-veined and disrupted diabase dykes.

Primary igneous layering is most common in the mafic cumulate facies, but is present to some extent in all units. Features such as graded bedding, cross-bedding and trough-bedding are present locally, and the attitude of primary layering can vary widely within a single outcrop.

The mafic cumulate facies contains some of the most interesting lithologies in the Adlavik Intrusive

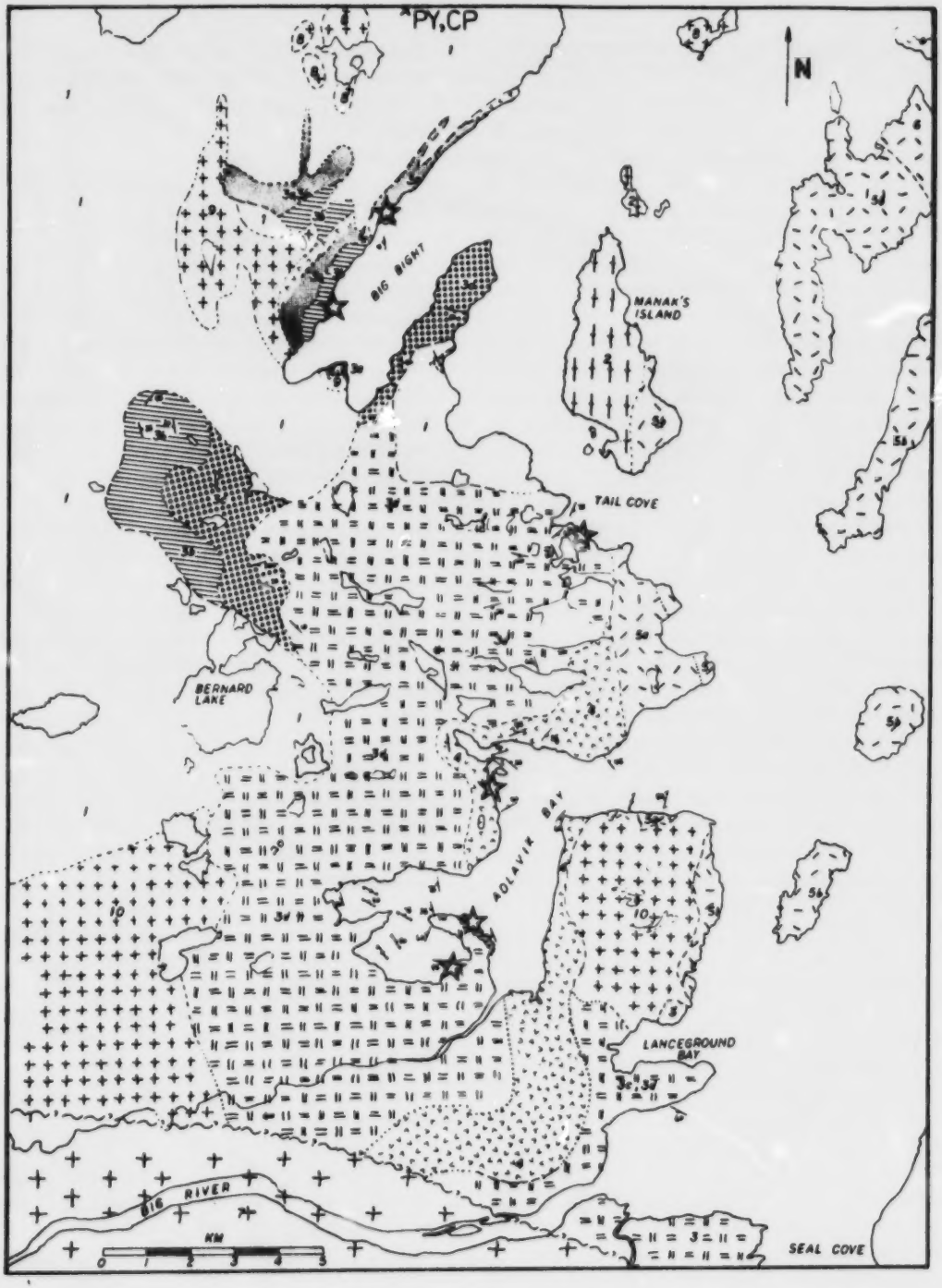


**Figure 2:** Preliminary geological map of the area around Adlavik Bay, compiled in part from Clark (1973). A general stratigraphic order is implied by the legend -- The Adlavik Intrusive suite is believed to predate most of the granitoid rocks within the Trans-Labrador batholith, but the age relationships of the granites themselves are unknown. Names applied to units 7 to 10 are informal.

**TRANS-LABRADOR BATHOLITH**

**Granitoid Rocks**

10 *Lanceground granite*

9 *Monkey Hill granite*

8 *Strawberry granite*

7 *Big River Granite*

**Adlavik Intrusive Suite**

6 *Syenite and Quartz Syenite*

5 *(a) Intrusive breccia with quartz monzonite neosome*
*(b) Massive monzonite and quartz monzonite*

4 *Diorite and monzodiorite*

3 *(a) Marginal gabbro and diabase*
*(b) Mafic cumulates*
*(c) Massive melanocratic gabbro*
*(d) Plagioclase cumulates*

**MAKKOVIKIAN BATHOLITH**

2 *Manak Island granodiorite*

**SUPRACRUSTAL ROCKS**

1 *Aillik Group: Felsic volcanic and volcaniclastic rocks, with minor metasedimentary rocks*

**SYMBOLS**

*Geological contact (approximate, inferred)*

*Igneous layering or foliation*

*Penetrative foliation*

*Fault (inferred)*

*Location of pegmatitic gabbro-diorite material containing minor sulphide*

suite, and many of the pegmatitic rocks appear to be associated with it. This association appears to be a reflection of cyclic behaviour which can be recognized locally at various scales throughout the intrusion, but is most obvious along the north shore of Big Bight. At least 2 cycles are present here, each comprising a basal ultramafic cumulate up to 10 m thick overlain by rhythmically layered mafic cumulate rocks in which hornblende appears to be of secondary origin. At the top of each cycle, pegmatitic gabbro and diorite form irregular masses of highly variable grain size which net-vein and disrupt the mafic cumulates. Acicular primary hornblende crystals up to 15 cm in length are characteristic of this material, and minor sulphide is locally present.

This cycle is interpreted to reflect simultaneous gravitational settling of mafic phases coupled with upward migration of residual liquids and fluids to form the hydrous pegmatitic rocks.

Evaluation of the PGE potential of these rocks has taken two forms:

1. Additional geochemical sampling coupled with analysis of existing samples for PGE to provide a better picture of spatial variation and identify any anomalous units or horizons. Average sample spacing across the Adlavik Intrusive suite has been reduced to approximately 1 km.

2. Selective sampling of pegmatitic lithologies, ultramafic rocks, sulphide-bearing gabbro and any other unusual rock types. Sampling has been concentrated in coastal areas (indicated in Figure 2), and in an inland area northeast of Bernard Lake underlain by the mafic cumulate facies. Extremely deep weathering and rusting in this area suggest the presence of sulphide, perhaps associated with olivine-bearing rocks.

Results are unavailable at present, with the exception of approximately 30 regional samples collected in 1985, which show no significantly anomalous PGE values.

## Preliminary Conclusions

The distribution of pegmatitic gabbro-diorite is more restricted than previously thought, and it is absent from large portions of the dominant plagioclase cumulate facies. Where present, it is irregular in form and restricted in extent, and the sulphide content is similarily sporadic, rarely exceeding 1 percent. These features suggest only limited potential for economic mineralization, but the often cryptic nature of PGE concentrations indicates that final conclusions must rest on analytical data, which should be available in early 1988.

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# Labrador Geochronology Database and Map Index

by

L.V.J. Crisby and A. Kerr
Labrador Mapping Section

## General Aims and Objectives

Geochronological data, in particular high precision U-Pb zircon data, are becoming increasingly important in establishing regional stratigraphic frameworks, particularily in Precambrian shield areas such as Labrador.

The rapid proliferation of such data, particularily as the result of a series of age-dating programs sponsored by the Department of Mines, has created the need for a central data repository for data collected in Labrador. We recognize also that such a system is an important requirement for the department as a whole, and that it will allow greater flexibility in our interpretation and presentation of geochronological and isotopic data.

The Labrador Mapping Section is in the initial stages of organizing a micro-computer based database to meet these requirements. Working files are being established according to dating method (e.g. Rb-Sr, U-Pb, K-Ar etc.). Within files, each individual date forms a single record containing basic information such as UTM coordinates, author, year carried out, stratigraphic unit and isotopic system. A range of other information is also present in an individual record, and is illustrated by Figure 1, which is a facsimile of the "form" used in data entry. A compilation of data for the Grenville Province by Easton (1986) includes some of the required information, and has been used both as a general model for format and as a checklist for some of the data.

We have attempted to deal with the "multiple age problem" (where a single set of measurements creates two or more ages, as in the case of lower and upper U-Pb intercepts, or Ar-Ar plateau ages representing different metamorphic events) by including "interpretative" information in each record, and allowing each individual age to form a discrete record. This includes the interpretation of meaning (e.g. crystallization, metamorphism etc.), as well as geological or isotopic information which may have a bearing on the validity of results. Whilst we recognize that some of this information may be subjective in the sense that it could reflect author bias, we feel that it is important that some attempt be made to include it.

The database is currently being compiled with the REFLEX database program marketed by Borland/Analytica. This program has a significant advantage over most alternatives as it allows modifications and additions to be made to the database structure itself as problems are detected. This system also allows the use of calculated fields which can be used to facilitate automatic recalculation of ages to recommended decay constants, and other mathematical transformations. Statistical breakdowns of data, frequency information and a range of graphical data displays are also available for interpretation of data. The program is also fully compatible with industry-standard products such as dBASE III, and transferring the database to another system should be simple. It may eventually become neccessary to transfer to the departmental mini-

GEOCHRON REPORT

DATA ENTRY FORM

----------N.D.M-----GEOCHRONOLOGY DATABASE-- ERRFLAG:

Catalog #: 12345 NTS Sheet: 14L NTS Zone: 20 Year: 1978

UTM East: 723490 UTM North: 6010010 Entered By: LC Entry Date: 9/21/87

----------FIELD INFORMATION----------

Rock Type: BSLT Major Unit: RAMAH GROUP Minor Unit: VOLCANICS

Structural Province: NAIN/CHURCHILL Metamorphic Grade: GREENSCHIST

Referenced Name: 10 SAMPLES Reference #: RM/MZ/MZK

Geological Comments: HIGHLY ALTERED

----------GENERAL INFORMATION----------

Material Dated: WR Isotope System: RB/SR

Decay Constant: 1.47E-11 Lab: GSC

----------GEOCHRONOLOGY DATA----------

Age: 1892 Positive Error: Negative Error:

Nature: ERRORCHRON %Error: 0

Interpretation: ALTERATION

Recalculated Age: 1959 Recommended Age: 1959

MSWD: 2.78 Intial Ratio: 0.7163 IR Error: ERROR

Recalculated Initial Ratio: ERROR

----------OTHER INFORMATION----------

Interpretation Comments: SR ENRICHMENT MAY BE DUE SIALIC ASSIMILATION

Reference: WANLESS & LOVERIDGE, 1978 GSC PAPER 77-14

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**Figure 1.** An example of the "form" used in data entry and the type of information contained in the various fields.

computer if the volume of data becomes extremely large. In addition to the computer file itself, an archive of original material will be assembled so that the numerical data itself can be readily accessed if required.

We envisage a number of possible uses for the system which go beyond the traditional "storage" concept. In particular, we want to emphasize the inclusion of geographic data which will allow the information to be used in the production of maps - for example, "thermochron" maps showing cooling patterns in various terranes, or maps showing the contribution of older crust in the generation of younger rocks. The data in the geochronology file can easily be used as input for the MAPGEN geographic information system developed by the USGS, which is currently operational on the minicomputer. We feel that interpretation of large scale geochronological patterns will be aided greatly by the ability to manipulate and summarize a large volume of data at one time.

## Progress to Date

Database design is now complete, and data compilation and entry is currently in progress. It should be completed in 1989. It is intended to make the information available in both printed form and on magnetic media such as floppy disks. The archive file with original material is being assembled as compilation proceeds.

## Index to Government Geological Mapping in Labrador

Geological Mapping in Labrador by the Newfoundland Department of Mines commenced in 1974 and to date, in co-operation with the Geological Survey of Canada, has covered approximately 50 percent of the region, largely at the 1:100,000 scale.

The last index to geological mapping in Labrador was published in 1977 (Harris, 1977) and consisted principally of industry and old Geological Survey of Canada sources.

An updated index at 1:1,000,000 scale is currently in preparation and will show the geographic areas covered by published maps of the Newfoundland Department of Mines and the Geological Survey of Canada.

Compilation work will be complete by the end of 1987 and publication is expected in 1988-89.

## Reference

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# Field work in the Nain - Strange Lake Corridor: the Hawk Lake - Lac Brisson Sector (14C/3,4,5; 24A/1,8)

by

Bruce Ryan, Dan Lee, and Don Dunphy
Labrador Mapping Section

The Nain - Strange Lake project was initiated in 1985 to map a 60-km-wide tract of Archean and Lower Proterozoic gneisses and Middle Proterozoic plutons between the Labrador coast and the Quebec border. The westernmost part of the corridor was mapped in 1987, thus completing the field survey. This western part, between Hawk Lake and Lac Brisson (Figure 1), comprises high-grade, polydeformed metamorphic rocks of the Lower Proterozoic Churchill Province (Trans-Hudson orogen), intruded by Middle Proterozoic quartz monzonites, (eg. Mistastin Batholith) and younger Middle Proterozoic peralkaline granite (Strange Lake pluton).

The metamorphic rocks of the project area are upper amphibolite to granulite facies gneisses of metaplutonic and metasedimentary - metavolcanic type. The field appearance of the metaplutonic rocks, chiefly quartzofeldspathic in composition, varies from mildly foliated to highly migmatitic, the lesser deformed and migmatized ones being elongate sheets emplaced during the later stages of Hudsonian deformation. Several disrupted leucogabbro - anorthosite complexes occur within the migmatite terrane. In areas where the Hudsonian overprint is relatively weak these anorthositic complexes and the enclosing migmatites are intruded by metadiabase dykes of probable Early Proterozoic age, metamorphosed to granulite facies during the Hudsonian event. Discordant dyke - gneiss contacts, and the presence of nearly identical leucogabbro-anorthosite elsewhere in the Archean craton of Labrador and Greenland, suggest that the Trans-Hudson orogen contains remnants of Archean crust in this area. Supracrustal rocks are less-abundant in the Hawk Lake - Lac Brisson area than to the east; the majority are sillimanite-bearing quartzite with lesser semi-pelitic gneiss. The westernmost part of the project corridor comprises a leucocratic to melacratic quartz-bearing gabbro-norite gneiss, injected by white garnetiferous granite.

Intrusive into the gneiss complex are three posttectonic granitoid bodies. The Mistastin Batholith comprises coarse grained hornblende-quartz monzonite and granite, with ovoidal mantled potassium feldspar megacrysts, typical of the iron-rich rapakivi intrusions of northern Labrador. A smaller pluton of coarse grained, nonporphyritic hornblende-biotite quartz monzonite occurs along the west margin of the map area. The Strange Lake peralkaline complex, noteworthy for its deposit of Zr, Y, Nb, Be and REE, occupies the westernmost part of the area south of Lac Brisson.

Although no significant showings of minerals of economic importance were discovered, small areas with anamolous radioactivity have been found. These are especially concentrated in a white pegmatoidal granite gneiss in the vicinity of "Esker lake". Samples from sulphide-rich zones within paragneiss east of the 1987 project area were assayed last winter, but results suggest that these zones contain only low concentrations of economically interesting elements.

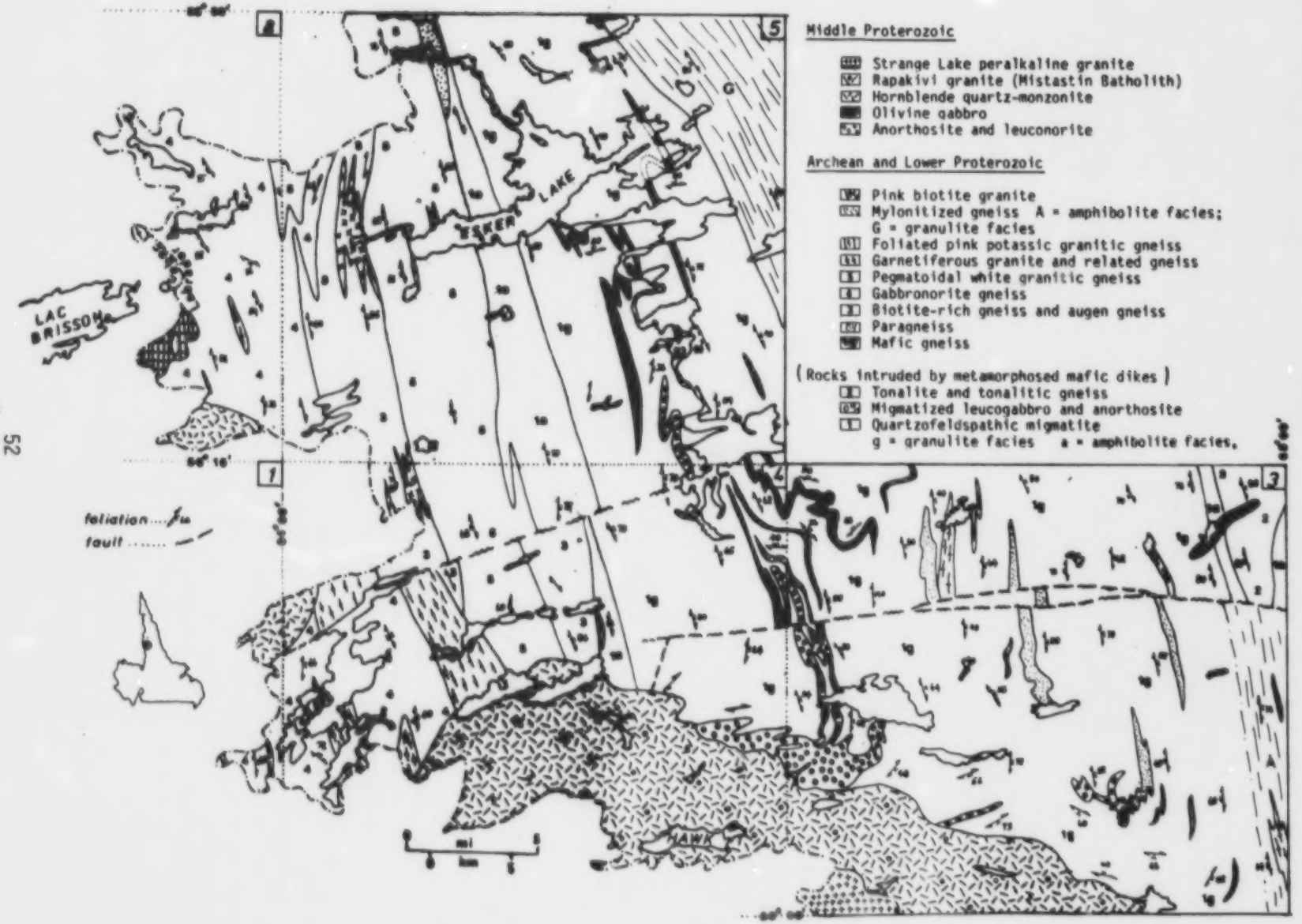


Figure 1. Sketch map of the geology of the Quebec-Labrador boundary area east of Lac Brisson. Numbers in boxes denote NTS 1:50,000 scale sheets: 14D/3,4,5, and 24A/1,8.

# REGIONAL GEOLOGY - NEWFOUNDLAND

# Geology of the east half of the Weir's Pond (2E/1) map area, northeastern Newfoundland

by

P. O'Neill
Newfoundland Mapping Section

During the 1987 field season, the east half of the Weir's Pond (2E/1) map area, was mapped at a scale of 1:50,000 (Figure 1).

Much of the west, central and southern portions of the area are underlain by variably deformed and metamorphosed sedimentary rocks of the Gander Group. In the northeast, these rocks are intruded by the post-tectonic Deadmans Bay Granite; in the central part of the area, the rocks are intruded by the syntectonic Ocean Pond granite.

Near Indian Bay Big Pond, the Indian Bay formation (Wonderly and Neuman, 1984) is shown to be conformable with the Gander Group, and is therefore redefined. That part of the Gander Group west of the Indian Bay formation and east of Weir's Pond is informally termed the Jonathan's Pond formation; it underlies much of the area formerly included in the Gander Group.

The eastern part of the Jonathan's Pond formation (Unit 1) is dominated by a monotonous sequence of thin and medium bedded sandstone and pelite. Conformable mafic dykes, 2 m or less in thickness, are more common in the western part of the area mapped, but form a minor component of the succession. Discontinuous layers and lenses of calc-silicate rock are common.

The Indian Bay formation is exposed on the shore and to the north of Indian Bay Big Pond; to the south, the formation thins and is less well exposed. Six rock units are defined within the formation. Unit 2 includes those rocks that define thegradational transition from the Jonathan's Pond formation to the Indian Bay formation. It also contains interbedded, grey and dark grey sandstone, and green and black pelite. The proportion of black pelite increases eastward until it forms about 50 percent of exposure. Black pelite marks the most distinctive change in sedimentation patterns.

Unit 3 consists predominantly of black pelite, commonly laminated with millimetre-thick sandy layers and rare black, quartz-granule sandstone. A distinctive 6-m-thick chert band is mappable along strike for several kilometres on the western margin of this unit. Units 2 and 3 are best exposed north of Little Bear Cove and Four Mile ponds.

Unit 4 is hornblende - feldspar porphyry containing local quartz phenocrysts set in an aphanitic, green or purple matrix. Three exposures of this rock occur on the north shore of Indian Bay Big Pond. A felsic volcanic rock is exposed in two localities south of Southern Pond and is included in Unit 4.

Two exposures of pillowed mafic volcanic rock, Unit 5, occur on two small islands in Indian Bay Big Pond, east of Unit 4. The pillows are well preserved, but the rock is highly altered. A hyaloclastite comprising vesiculated blocks of this mafic rock is exposed nearby, and also occurs as numerous boulders on the shoreline of the pond. Unit 5 is not exposed north or south of the pond.

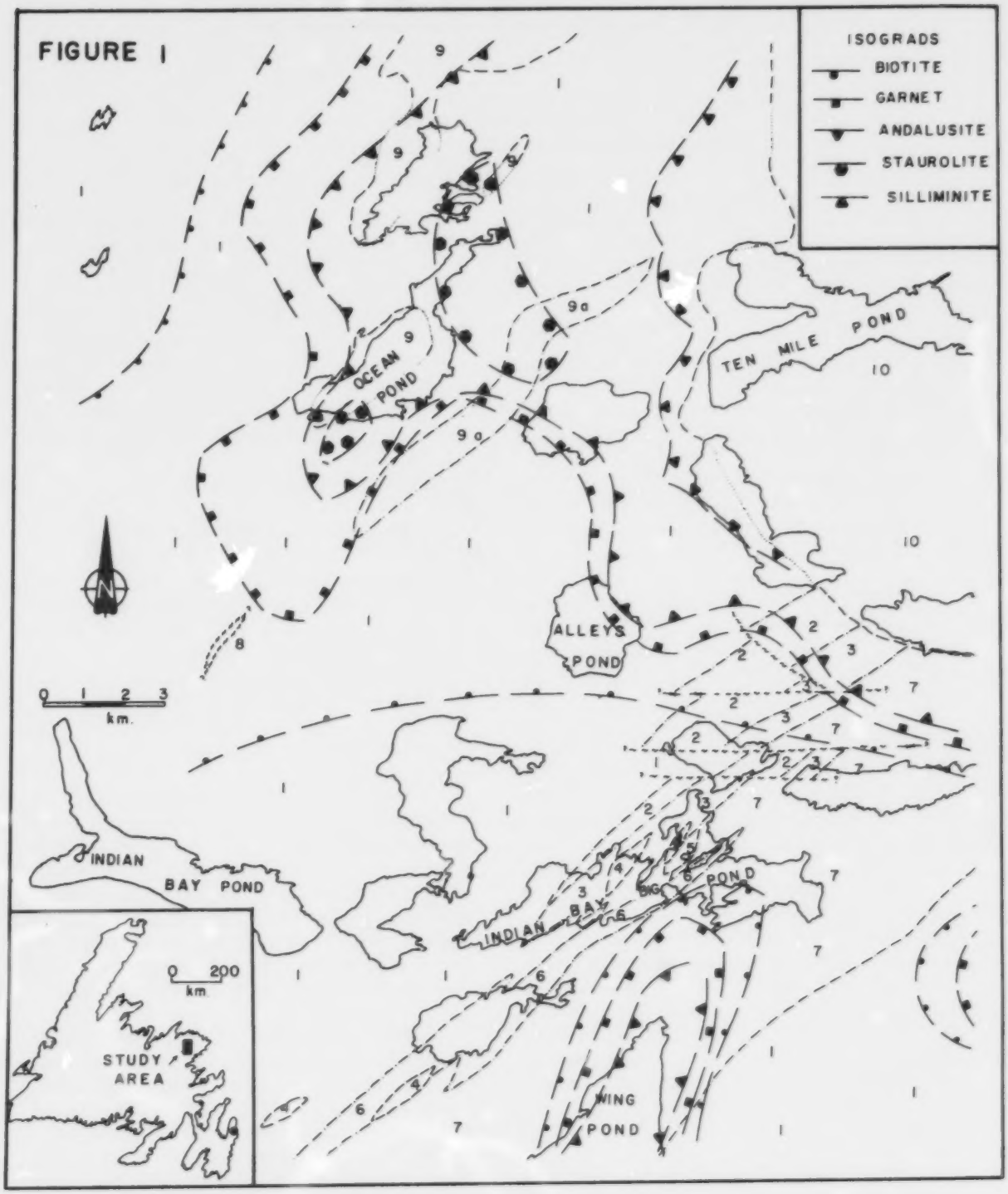


**Figure 1:** Geology of the east half of the Weir's Pond map area.

LEGEND

10 Deadman's Bay Granite: non-foliated, K-feldspar megacrystic, biotite granite

9 Ocean Pond granite: equigranular muscovite granite, generally moderately foliated; 9a - zone containing numerous Ocean Pond granite and pegmatite sheets

8 Coarse grained pyroxenite and pyroxene gabbro, locally undeformed

Gander Group

Indian Bay formation

7 Grey and dark-grey psammite, grey - green and black pelite, thin calc-silicate beds

6 Medium grained, medium to thick bedded, buff and maroon micaceous sandstone; green and maroon siltstone, minor black pelite, fossiliferous argillaceous rocks, minor felsic tuff (?); intraformational pebble and cobble conglomerate; minor grey sandstone

5 Pillowed mafic volcanic rock, pillow breccia and/or hyaloclastie

4 Felsic to intermediate intrusive rock containing hornblende, feldspar and rarely, quartz phenocrysts

3 Laminated black pelite containing laminae of thin sandy layers, minor thin grey sandstone beds, rare black quartz-granule sandstone and a 6 m chert band

2 Grey psammite, grey - green pelite, black pelite and dark - grey psammite

Johathan's Pond formation

1 Medium to thinly bedded grey laminae psammite, grey - green pelite and quartzite, minor quartz-granule beds, amphibolite and calc-silicate layers

Unit 6 includes medium grained, medium to thick bedded, buff and maroon sandstone, thinly bedded maroon and green siltstone and black pelite. The micaceous character and colour of the sandstone differentiate it from sandstone of the Jonathan's Pond formation. Fossiliferous, argillaceous boulders, which are common on the shores of the pond, are considered to be from this unit. Boulders of a pebble and cobble conglomerate, which contain detritus from some or all of Units 2 to 7, are common on the shores of Indian Bay Big Pond and Little Bear Cove Pond. Grey sandstone, very similar to that of the Jonathan's Pond formation, is locally intercalated with the buff and maroon sandstone of Unit 6.

Unit 7 defines a gradational return to sedimentary rocks typical of the Jonathan's Pond formation. It consists of interbedded grey and dark-grey psammite, grey-green and black pelite and numerous calc-silicate bands.

North of Indian Bay Pond, a fault-bounded sliver of pyroxenite and pyroxene gabbro (Unit 8) extends for approximately 2 km along strike and is approximately 100 to 200 m thick. The eastern margin of the body is intensely foliated whereas the western edge is undeformed. Gabbro pegmatite and locally granite pegmatite (the latter contains tourmaline) invade the pyroxene gabbro.

All of the above units (except Unit 8) exhibit the effects of two stages of deformation. The first deformation produced isoclinal, locally tight folds that have a well developed axial-planar cleavage. Upright, open to tight folds of the second deformation are associated with a heterogenously developed crenulation cleavage. A high-strain zone, apparently associated with $D_1$ is defineable near and northeast of Wing Pond. The zone is characterized by a locally mylonitic $S_1$ fabric and the profuse development of quartz veins, many of which are reduced to platelets and highly attenuated millimetre-thin "stringers". At Indian Bay Big Pond, the zone narrows and the strain is less intense; however, northeast of Little Bear Cove Pond, the rocks, including those of the Indian Bay formation, are highly strained. The rocks are more obviously and complexly folded in the high-strain zone; many of the folds are asymmetric and reclined.

Greenschist and amphibolite facies metamorphism has affected many of these rocks, especially near the Ocean Pond granite and the Deadmans Bay Granite. These higher grade metamorphic rocks have previously been included in the Square Pond Gneiss; however, no gneissosity is developed and the rocks are here included in the Gander Group. Garnet, andalusite, staurolite and sillimanite isograds are approximately symmetrically related to these granites. However, final emplacement of the Deadman's Bay Granite is post the regional metamorphism which is best developed in the north of the area.

## Mineralization

The contact between the chert and laminated black siltstone of Unit 6, locally contains disseminated pyrite and molybdenite. Felsic to intermediate intrusive or sub-intrusive rocks of Unit 5 also contain disseminated pyrite. Units 5 and 6, along with mafic volcanic rocks of Unit 4 are interpreted to be part of a single volcanic episode.

## Reference

Wonderly, P.F. and Neuman, R.B.
1984: The Indian Bay Formation: fossiliferous Early Ordovician volcanogenic rocks in the northern Gander Terrane, Newfoundland, and their regional significance. Canadian Journal of Earth Sciences, Volume 21, pages 525-532.

# Geology of the Snowshoe Pond (12A/7) Area, Newfoundland

by

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Newfoundland Mapping Section

During 1987, 1:50,000 mapping was completed in the Snowshoe Pond area.

The map area (Figure 1) is divided into two parts by Noel Paul's Line, a major fault zone which runs southeast of Lake Douglas and south of Rodeross Lake:

1. Clastic metasedimentary rocks, provisionally equated with the Early to Middle Ordovician Spruce Brook Formation, occur to the south and southeast of the fault.

2. Volcanic rocks and associated sedimentary rocks and intrusions, typical of the Newfoundland Central Volcanic Belt, occur in the northwest.

Granite and granodiorite intrusions are most common in the south and southeast, but some also cut rocks of the Central Volcanic Belt. A gabbro-ultramafic intrusion cuts across Noel Paul's Line at Rodeross Lake.

The clastic metasedimentary rocks of Unit 1 consist of interbedded quartzite, psammite and semipelite. Metamorphic grade increases from chlorite and biotite southeast of Lake Douglas, through andalusite grade near Hospital Pond, to sillimanite grade at Blizzard Pond and Meelpaeg Lake. Unit 9 consists of migmatite derived principally by partial melting of Unit 1. Mafic dykes and granite of Unit 8 intruded Unit 1 pretectonically. Rocks of Units 1 and 8 have been polydeformed and mylonitic zones are common, especially southeast of Lake Douglas, at Snowshoe Pond, and southeast of Rodeross Lake.

Unit 2 consists of sedimentary and felsic volcanic rocks, moderately deformed and metamorphosed in the greenschist facies. The unit wedges out between two converging faults at Noel Paul's Brook.

Units 3 to 7 are all moderately deformed to almost undeformed, and are metamorphosed in the greenschist facies. Unit 3 consists of mafic volcanic rocks with numerous occurrences of pillow lava and some volcanic breccia. Unit 4 is composed mainly of volcaniclastic sedimentary rocks, but also includes minor mafic and felsic volcanic rocks and mafic intrusions. Units 5 and 6 are on-strike equivalents of the Tally Pond volcanic rocks of the Victoria Lake Group. They consist of mainly mafic volcanic and hypabyssal intrusive rocks, and sedimentary rocks respectively. Unit 7 is the Rogerson Lake Conglomerate, a probable fluviatile deposit of suspected Silurian age, which is thought to be faulted against or unconformably overlie the Ordovician rocks.

Granitoid rocks of Units 8, 10, 12 and 13 represent various intrusive events. Unit 8 is restricted to south of Noel Paul's Line and is bounded by the fault near Rodeross Lake. Unit 10 is composite and consists of rocks that have been moderately foliated or are not deformed at all. Rocks of the unit near Wilding Lake intrude across Noel Paul's Line. Units 12 and 13 are small, distinctive bodies that are late or post-tectonic.

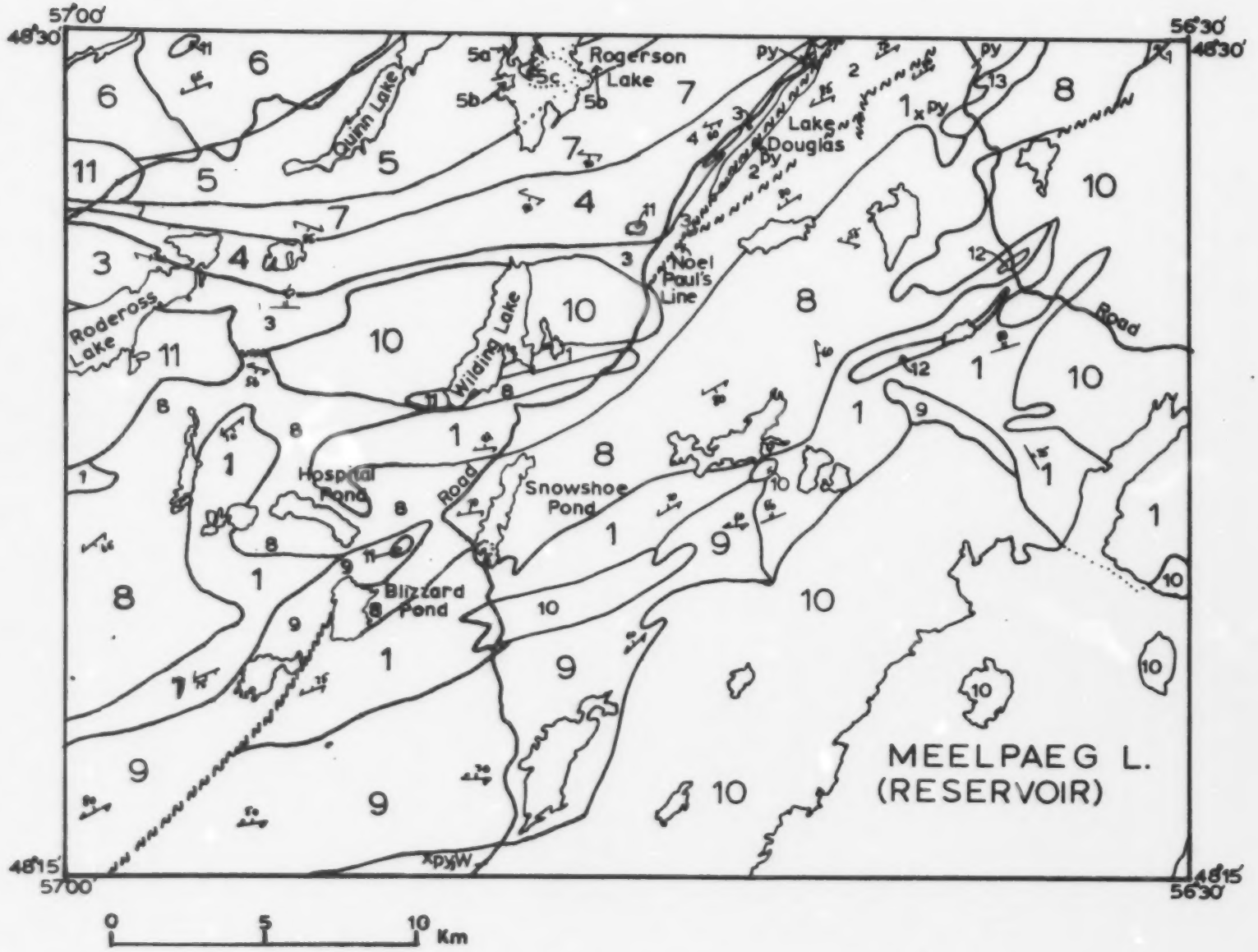


Figure 1: General geology of the Snowshoe Pond (12A/7) map area.

LEGEND

**SILURO-DEVONIAN**

13 White leucogranite

12 Garnet-tourmaline-muscovite granite, pegmatite

11 Hornblende-biotite gabbro or diorite, and minor unseparated ultramafic rock; may include Ordovician intrusions

10 Porphyritic or equigranular, grey or pink, biotite granodiorite; locally contains muscovite; moderately foliated to unfoliated; includes part of North Bay Granite

9 Migmatite, rich in biotite schlieren and metasedimentary fragments; mainly derived by partial melting of Unit 1

8 Equigranular to megacrystic, foliated to mylonitic, grey or pink, biotite granite

**SILURIAN?**

7 Rogerson Lake Conglomerate: purple, clast-supported, polymictic conglomerate and sandstone

**ORDOVICIAN**

6 Victoria Lake Group: unseparated sedimentary and minor mafic volcanic rocks

5 Tally Pond volcanics (Victoria Lake Group)
- 5a Mafic volcanic rocks
- 5b Mafic dykes and sills
- 5c Felsic intrusive rocks

4 Breccia, conglomerate, sandstone and shale, and minor mafic and felsic volcanic rocks; includes unseparated mafic intrusions

3 Mafic volcanic rocks, including pillow lava

2 Grey, felsic, crystal tuff and felsic intrusive(?) rocks, interlayered with shale, sandstone and conglomerate

1 Grey quartzite, psammite and schist (probably equivalent to Spruce Brook Formation)

Mafic intrusive rocks of Unit 11 are dominated by the large intrusion at Rodeross Lake, which is tilted but otherwise undeformed and cuts across Noel Paul's Line. It includes pyroxenite in the Snowshoe Pond area and olivine-rich ultramafic rocks in the Victoria Lake area to the west.

The principal exploration targets in the area are:

1. Precious and base metals in volcanic rocks of Units 2-6. These rocks are commonly pyritiferous and contain prominent gossans on the shores of Lake Douglas and east of Rodeross Lake.

2. Precious metals in major fault zones especially south and east of Lake Douglas. Mylonitic rocks in Noel Paul's Brook are pyritiferous.

3. Tungsten mineralization in granitic and migmatitic rocks of Units 8, 9, 10, and 12. A new occurrence of pyrite and wolframite was found in a quartz vein cutting granite of Unit 10 near the south edge of the map area.

4. The ultramafic phases of the mafic intrusion (Unit 11) at Rodeross Lake may have potential for concentrations of Platinum-Group Elements.

# Geology of the Hungry Grove Pond (1M/14) map area

by

W. Lawson Dickson
Newfoundland Mapping Section

The oldest rocks in the map area lie to the south of the Hermitage Bay Fault which separates the Late Precambrian Avalon Terrane (Units 1-4) to the south, and the Early Paleozoic Gander Terrane (Units 5-10) to the north (Figure 1).

In the Rally Pond area, the Belle Bay Formation (Unit 1) of the Long Harbour Group, is dominated by rhyolitic flows and tuffs and minor basaltic flows. A small plug of gabbro has intruded the tuffs southeast of Rally Pond. A series of ridges, trending southwest from Little Blue Hill Pond, is underlain by sediments of the Rencontre Formation (Unit 2) of the Long Harbour Group. Thick bedded, grey sandstone hornfels dominates the southeastern portion of the area; well cleaved, locally very rusty, micaceous sandstone dominates the central and western portion; pebble conglomerate and sandstone dominate the northern portion of the area.

Units 3 and 4 comprise the Simmons Brook Batholith, a bimodal gabbro - granodiorite complex. Diabase dykes are common throughout the batholith. Extensive brecciation and chloritic alteration of the batholith is exposed along the Hermitage Bay Fault southeast of North East Brook.

The sedimentary and volcanic rocks of the Baie d'Espoir Group form a series of northeast-trending, interbedded and fault-juxtaposed units. The sequence is more deformed and metamorphosed in the southeast (Units 5 and 6) and least deformed and metamorphosed in the northwest (Units 11-13). The volcanic rocks are highly schistose and quartz veining is common. Probable magnesite and quartz-carbonate alteration of the chlorite schists occur along the contact between the northwestern belt of chlorite schist (Unit 9) and quartz sericite schist (Unit 8) to the southeast. Ni and Cr analyses of magnesite (Mg on map) are given in Table 1 and indicate a probable ultramafic parentage for the magnesite. The presence of ultramafic rocks indicates a major tectonic discontinuity within the Isle Galet Formation. This is significant for mineral exploration as the Le Pouvoir antimony - gold showing lies along this zone.

Table 1. Ni and Cr analyses (in g/t) for samples of probable magnesite from the Le Pouvoir Horizon

| Sample | Cr | Ni |
|---|---|---|
| 2242933 | 1780 | 1340 |
| 2242943 | 1370 | 1210 |

An extensive area of biotite schist lies within the North West Brook Complex granitoids. These metasediments are similar to the metasediments that form the southeastern part of the Baie d'Espoir Group (Unit 5), west of Western Pond. These metasediments are along strike from the Little Passage gneiss (Colman-Sadd, 1976) and are here considered to form part of the Baie d'Espoir Group. A silicified shear zone separates the Little Passage gneisses from silicified rhyolites (Unit 7) west of Medonnegonix Lake.

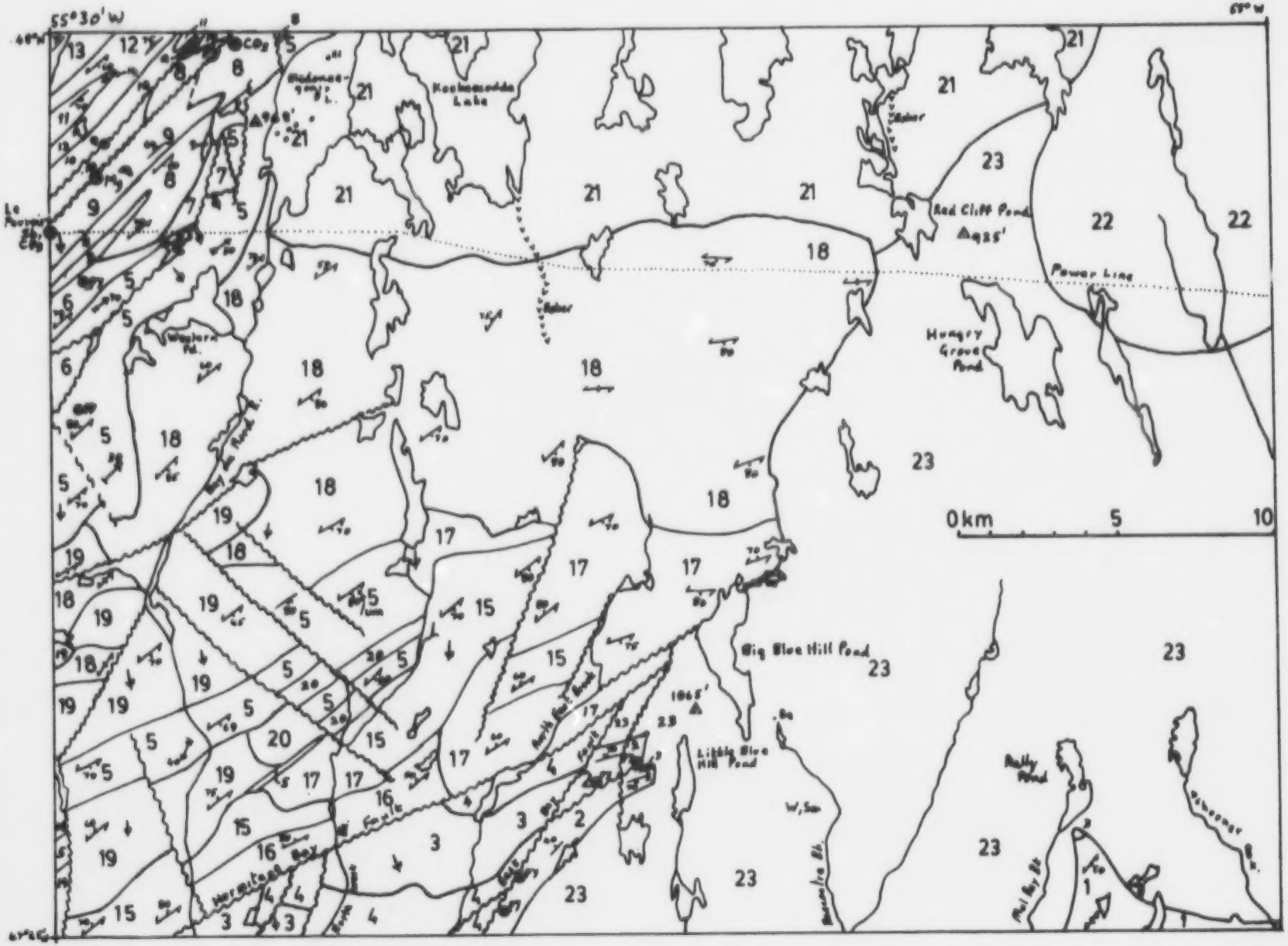


Figure 1: Geology of the Hungry Grove Pond (1M/14) map area.

LEGEND

DEVONIAN

ACKLEY GRANITE SUITE (Units 22 and 23)

23 Pink and red, massive, coarse grained, leucocratic equigranular, biotite granite and minor fine grained, quartz - feldspar porphyritic, biotite granite

22 Pink, massive, coarse grained, leucocratic, K-feldspar porphyritic, biotite granite

21 KOSKAECODDE PLUTON - Pink to grey, massive, coarse grained, K-feldspar porhyritic, biotite granite

SILURIAN - DEVONIAN

NORTH WEST BROOK COMPLEX (Units 15 to 20)

20 Pink, foliated, fine grained, equigranular, biotite granite

19 Pink to buff, foliated, medium grained, equigranular and K-feldspar porphyritic, biotite ± muscovite, granite

18 Pink to buff, foliated, coarse grained, K-feldspar porphyritic, biotite granite; cut by dykes of Unit 19

17 Pink to buff, foliated, medium grained, equigranular, biotite ± muscovite granite

16 Buff to grey, foliated, medium grained, equigranular, biotite granodiorite

15 Orange to black, strongly foliated, coarse grained, feldspar-porphyritic, biotite granodiorite

SILURIAN?

14 Grey, foliated and sheared, medium grained, equigranular, biotite granodiorite

ORDOVICIAN

BAIE D'ESPOIR GROUP (Units 5 to 13)

13 RICHES ISLAND FORMATION - Grey, medium bedded, cleaved sandstone and slate

ISLE GALET FORMATION - Units 6 to 12

12 Rhyolitic flows, bedded lapilli tuff, fine grained waterlain tuff, and quartz - feldspar-crystal tuff (probable ash flow)

11 Medium to coarse grained, strongly cleaved, poorly sorted sandstone and pebble conglomerate with abundant acid volcanic clasts

10 Grey, medium to thick bedded slate, siltstone and sandstone

9 Strongly deformed, chlorite ± sericite schist, and massive basalt flows; minor undivided grey slate. Extensive carbonate alteration northeast of the Le Pouvoir Sb showing

8 Strongly deformed, quartz - sericite ± chlorite schist (meta-acid volcanics) and minor chlorite schist and slate

7 Pink to red, weakly cleaved, rhyolitic tuff and flows

6 Highly folded and quartz-veined, grey to black, locally pyritic pelite and semipelite

5 LITTLE PASSAGE GNEISS(?) Highly deformed, grey to black, pelitic to psammitic, biotite schist and biotite gneiss and migmatite, quartz-rich biotite psammite. Dominantly pelitic biotite schist within the North West Brook Complex.

LATE PRECAMBRIAN

SIMMMONS BROOK COMPLEX - Units 3 and 4

4 Pink to green, massive and locally brecciated, medium to coarse grained, equigranular, hornblende - biotite granodiorite

3 Black to dark green, massive, medium to coarse grained, gabbro, diabase and minor pyroxenite

LONG HARBOUR GROUP - Units 1 and 2

2 RENCONTRE FORMATION - Grey, massive, thick bedded sandstone hornfels, grey and brown, strongly cleaved, medium bedded sandstone and siltstone, grey, micaceous, thick bedded sandstone, medium bedded pebble conglomerate and sandstone, minor thick bedded limestone

1 BELLE BAY FORMATION - Grey to buff, flow layered rhyolite, rhyolitic tuff, massive basalt flows

SYMBOLS

| | |
|---|---|
| W | Tungsten |
| Sn | Tin |
| Be | Beryl |
| Sb | Stibnite |
| py | Pyrite |
| Q | Quartz veining |
| $CO_3$ | Carbonate alteration |
| Mg | Magnesite |
| UM | Ultramafic erratics |

The North West Brook Complex is dominated by medium grained, biotite ± muscovite granite and granodiorite (Units 16, 17, 19, 20), in the south, and coarse grained, K-feldspar-porphyritic granite (Unit 18) in the north. Dykes of equigranular granite are common in Unit 18. The porphyritic granodiorite (Unit 15), in the southwest corner of the map area is the most highly deformed unit of the complex and is probably correlative with the Gaultois Granite. Zones of more intense deformation occur within the generally mildly deformed Unit 18.

The contacts between the deformed units and the Koskaecodde Pluton and the Ackley Granite Suite were mapped out. These granites are clearly intrusive into the major units except the Simmons Brook Batholith. The Koskaecodde Pluton is generally more mafic (approximately 5 percent biotite) than the Ackley Granite Suite (1 percent biotite). The contact between Unit 18, of the North West Brook Complex, and the Koskaecodde Pluton is fairly well defined by the close proximity of deformed and undeformed granites. The contact between the Ackley Granite Suite and the North West Brook Complex is well exposed in several places northeast of Big Blue Hill Pond.

Glacial striae indicate the dominant ice-flow direction is toward 170°. Numerous ultramafic boulders were found in the centre of the North West Brook Complex. The closest ultramafic body lies 40 km to the north-northwest, near Middle Ridge.

The greatest mineral potential lies in the Isle Galet Formation in the Le Pouvoir horizon and gold has been reported in the southwest extension of Unit 12 (Kim Lake Horizon) near Little River, and at Kim Lake, 13 km to the northwest. The extensive gossan zones and quartz veining in Units 5 and 6 are worthy targets for gold exploration. The sheared silicified contact between Units 5 and 7, although lacking pyrite, is another potential target. Samples have been collected from these areas and will be assayed for gold and analyzed for other significant elements.

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## Northwest Avalon Zone: parts of St. Brendan's (2C/13) and Eastport (2C/12)

by

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Detailed mapping (O'Brien) and allied sedimentological studies (Knight) of the Late Precambrian Avalonian rocks of the St. Brendan's (2C/13) and Eastport (2C/12) map areas (Figure 1), initiated in 1986, were continued during the 1987 field season.

The map area is crossed by several, major, northeasttrending faults, which bound several distinct lithostratigraphic packages (Figure 2). In the west the Dover Fault juxtaposes schistose and locally mylonitic volcanic rocks of the western belt of the Love Cove Group with gneisses and granitoids of the Gander Zone. To the east the Howses Cove and Bloody Reach faults delineate the major outcrop area of the dominantly sedimentary Musgravetown Group and the overlying Chapel Island Formation of the Youngs Cove Group. That part of the succession between the Bloody Reach and Cottel Island faults consists of a second, eastern belt of the Love Cove Group volcanic rocks, intruded by pretectonic granitoids. These rocks are overlain unconformably by a thin sequence of bimodal, subaerial volcanic and red clastic sedimentary rocks. The latter are tentatively correlated with volcanic rocks of the Musgravetown Group west of the Bloody Reach fault. The Cottel Island fault marks the western limit of the Connecting Point Group, a thick and extensive marine clastic succession with major pyroclastic volcanic components at and near its base.

Within the map area, rocks of the Love Cove Group form two geographically separate belts. The

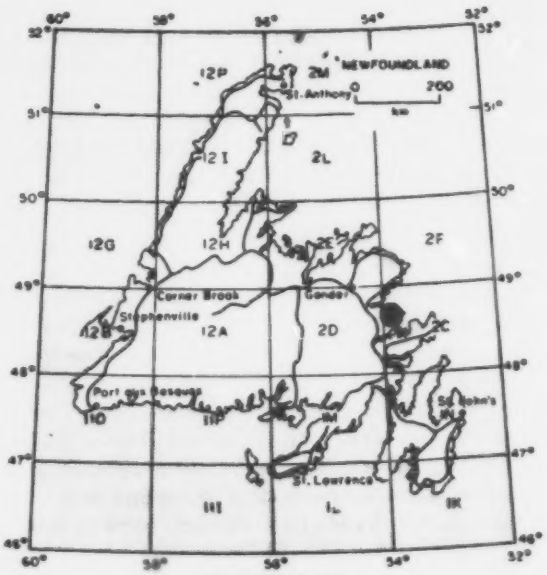


**Figure 1:** Location of study area.

eastern belt occupies the core of a major anticlinorium, and is continuous southward, through the type area at Clode Sound, to the southern Burin Peninsula. The western belt, bounded to the west along its entire length by the Dover Fault, is in fault contact with the Musgravetown Group. The Love Cove Group contains variably strained, schistose, and locally mylonitic flows and pyroclastic rocks of intermediate, mafic and locally rhyolitic composition. In its upper part, the group is dominated by black slates with interbedded vitric tuff, quartz crystal tuff, lithic tuff and agglomerate.

The Connecting Point Group conformably overlies the Love Cove Group. Divisions of the Connecting Point Group, established in 1986 (O'Brien, 1987; Knight, unpublished

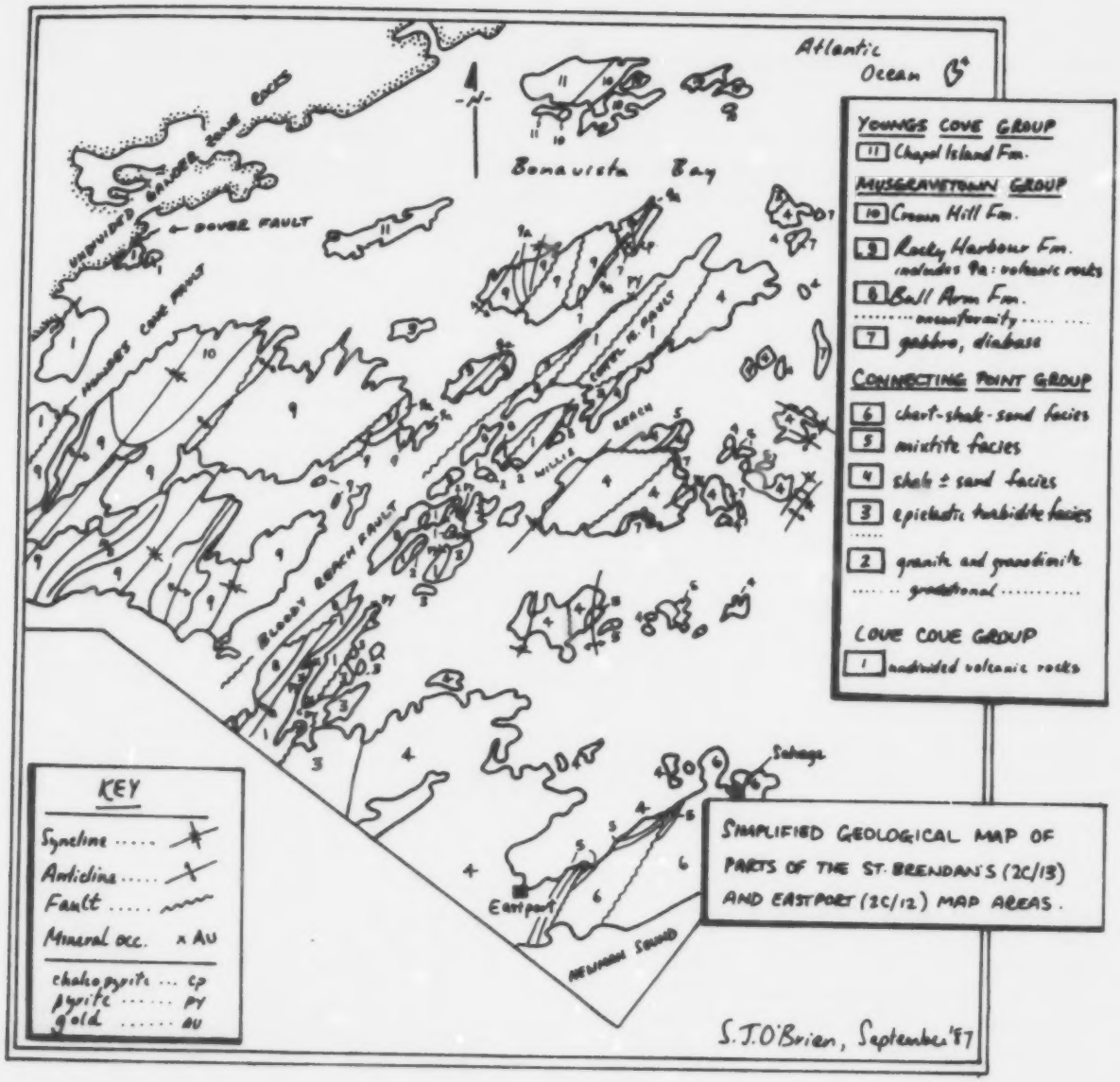


**Figure 2:** Simplified geological map of parts of the St. Brendan's (2C/13) and Eastport (2C/12) map areas.

data) have been extended northward into the St. Brendan's map area, where a total of 10 distinctive lithofacies have been recognized (see Knight and O'Brien, this volume). The lower stratigraphic levels of the group are well exposed on the western, upright to overturned limb of a syncline, whose axis pass north-northeastward near the west end of Willis Island (Figure 1). The tuffs and slates that dominate the upper part of the Love Cove Group occur as interbeds in the basal part of the Connecting Point Group, suggesting a transitional basal contact. The dominant lithofacies of the group are well bedded, turbidite-facies sandstone and shale, massive and thick-bedded sandstone, pebbly sandstone and rare conglomerate, thin-bedded sandstone and siltstone, and black

shale with thin sandstone laminae. Similar facies, together with a distinctive mixtite/olistostrome unit representing an admixture of thin-bedded and thick-bedded facies together with silicic volcanic detritus, are found on the upright, gently-dipping east limb of the structure, as well as in a number of open folds in the area east and southeast of Willis Island. These are overlain by bedded siliceous argillites, cherts and thick, coarsening-upward sequences of silicified turbidites. The upper parts of the Connecting Point Group are locally cut by swarms of syn- sedimentary mafic dykes.

The Musgravetown Group, west of the Bloody Reach fault has been subdivided into: (1) a basal unit of rhyolite flows and ash-flow tuffs (Bull Arm Formation), disconformably overlain by (2) a succession of green, wispy-laminated sandstone and planar cross-bedded conglomerate, with minor flows and pyroclastic rocks (Rocky Harbour Formation), capped by (3) a gradationally overlying, fining-upward sequence of red, boulder to pebble conglomerate, and red and green sandstone and granule conglomerate (Crown Hill Formation). East of the Bloody Reach fault, the Musgravetown Group is represented by a thin succession of (from base to top) rhyolite, basalt, green sandstone and red conglomerate. The Musgravetown Group unconformably overlies both Connecting Point and Love Cove groups.

The youngest rocks in the map area are green and grey, locally micaceous and in places quartose, sandstone and siltstone, which gradationally overlie red and green sandstone of the upper part of the Musgravetown Group. These rocks, exposed only on Deer Island and Lockers Flat Island, are here correlated with the Chapel Island Formation of the Youngs Cove Group.

The most significant economic aspect of this years study is the discovery of numerous pyritic, silicified zones within felsic volcanic rocks of the Love Cove Group. These zones lie along strike of the altered rocks on Long Reach Island (O'Brien, 1987). New zones of silicification with pyrite and locally elevated gold values were discovered in at least twelve localities. Approximately one half of the assay results are available at this time. Gold assays up to 575 ppb have been obtained locally.

Reference

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1987: Geology of the Eastport (west half) map area, Bonavista Bay, Newfoundland. In Current Research, Newfoundland Department of Mines and Energy, Mineral Development Division, Report 87-1, pages 257-270.

# Paleontological investigations in Newfoundland, 1987

by

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## Western Newfoundland

### Canada Bay

Lower and Middle Cambrian rocks of the Canada Bay region (Figure 1) were again the target of detailed biostratigraphic sampling for trilobites. The units investigated this year were the siliciclastic and Bridge Cove members of the Hawke Bay Formation. Particular attention was paid to the siliciclastic member, exposed along the western side of Chimney Arm, because this unit was incompletely sampled in 1986.

Possible Plagiura Zone (earliest Middle Cambrian) trilobites were discovered in the siliciclastic member of the Hawke Bay Formation overlying known late Early Cambrian Bonnia-Olenellus Zone trilobites. Probable Albertella Zone trilobites were recovered from the Bridge Cove Member underlying the Glossopleura Zone fauna discovered last year (Knight and Boyce, 1987). At least two new trilobite species were discovered in the sequence.

### Hare Bay

Reconnaissance sampling, of the Watts Bight, Boat Harbour, Catoche and Aguathuna formations (St. George Group), for trilobites and conodonts commenced in Hare Bay.

### Pistolet Bay

On Schooner Island biostratigraphic sampling of the St. George Group for trilobites and conodonts was completed. The units investigated

**Figure 1:** Location of study areas.

were the Barbace Cove Member of the Boat Harbour Formation and the lower three members of the Catoche Formation.

On Burnt Island, detailed biostratigraphic sampling of the Upper Bioturbated Member and the White Limestone Member of the Catoche Formation was completed. Two sections were investigated. One was on the plateau on the west side of the peninsula; the other was along the northwest shore.

With the addition of biostratigraphic information from sections at Boat Harbour and Cape Norman, the succession of St. George Group trilobite faunas in the Pistolet Bay area can now be established.

On the south shore of Pistolet Bay, three fossiliferous horizons were sampled in the vicinity of Triangle Point, near the old St. Anthony airport. According to Ms. L. Quinn (Memorial University of Newfoundland), the collections are from the upper part of the Goose Tickle Formation.

### Eddies Cove West

Biostratigraphic sampling of the Boat Harbour Formation (St. George Group) for trilobites and conodonts near Eddies Cove West was completed.

### Cow Head to Corner Brook

Boyce and Dr. S.H. Williams (Memorial University of Newfoundland) are jointly studying new "autochthonous" Tremadoc trilobites from the Cow Head Group of the Humber Arm Allochthon. Boyce is also working with J.W. Botsford (Memorial Univeristy of Newfoundland) on late Middle Cambrian to Early Ordovician trilobite faunas recently recovered from the Cooks Brook Formation (Curling Group) of the Humber Arm Allochthon (Botsford et al., 1986).

## Central Newfoundland

### Long Island

The Cutwell Group fossil localities of Strong and Kean (1972) on Long Island were visited with B. Kean. There were no new macrofossil finds, however, five conodont samples were taken.

### Indian Bay Big Pond

O'Neill collected more brachiopod and trilobite material from the Indian Bay formation at Indian Bay Big Pond. His collections, which Boyce is studying, augment those of Wonderley and Neuman (1984) and Boyce (1987). The new material is probably the best preserved of all the collections. Unfortunately, like the others, it was obtained from talus.

### Weir's Pond Area

Three new trilobite localities were discovered in the basal Davidsville Group in the vicinity of Weir's Pond.

Deformed shales of the Davidsville Group at Weir's Pond yielded abundant graptolites, possibly Climacograptus. This locality was originally discovered by Ash in 1985.

## Eastern Newfoundland

### Manuels River

Late Early Cambrian trilobites were collected from an old obscure locality near Manuel's River. A rich trilobite fauna was collected from red and green shale and rottenstone nodules of the Brigus Formation 0.6 km west of the Manuel's River bridge.

The bulldozed and blasted area of outcrop along the road is apparently the roadside Catadoxides fauna locality of Matthew (1899) and Howell (1925, Figure 3). Among the trilobites collected were:

Calodiscus lobatus (Hall)
Callavia broeggeri (Walcott)
?Catadoxide magnificus (Matthew)
Micmacca sp. undet.
Protolenus sp. undet.
Serrodiscus bellimarginatus (Shaler and Foerste)
Serrodiscus ?comleyensis (Cobbold)
Strenuella strenua (Matthew)
Triangulaspis vigilans (Matthew)

The fossils were collected from both outcrop and talus.

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# Report on geological mapping in the Roti Bay - La Poile Bay area, southwestern Newfoundland (110-9 and 110-16)

by

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Newfoundland Mapping Section

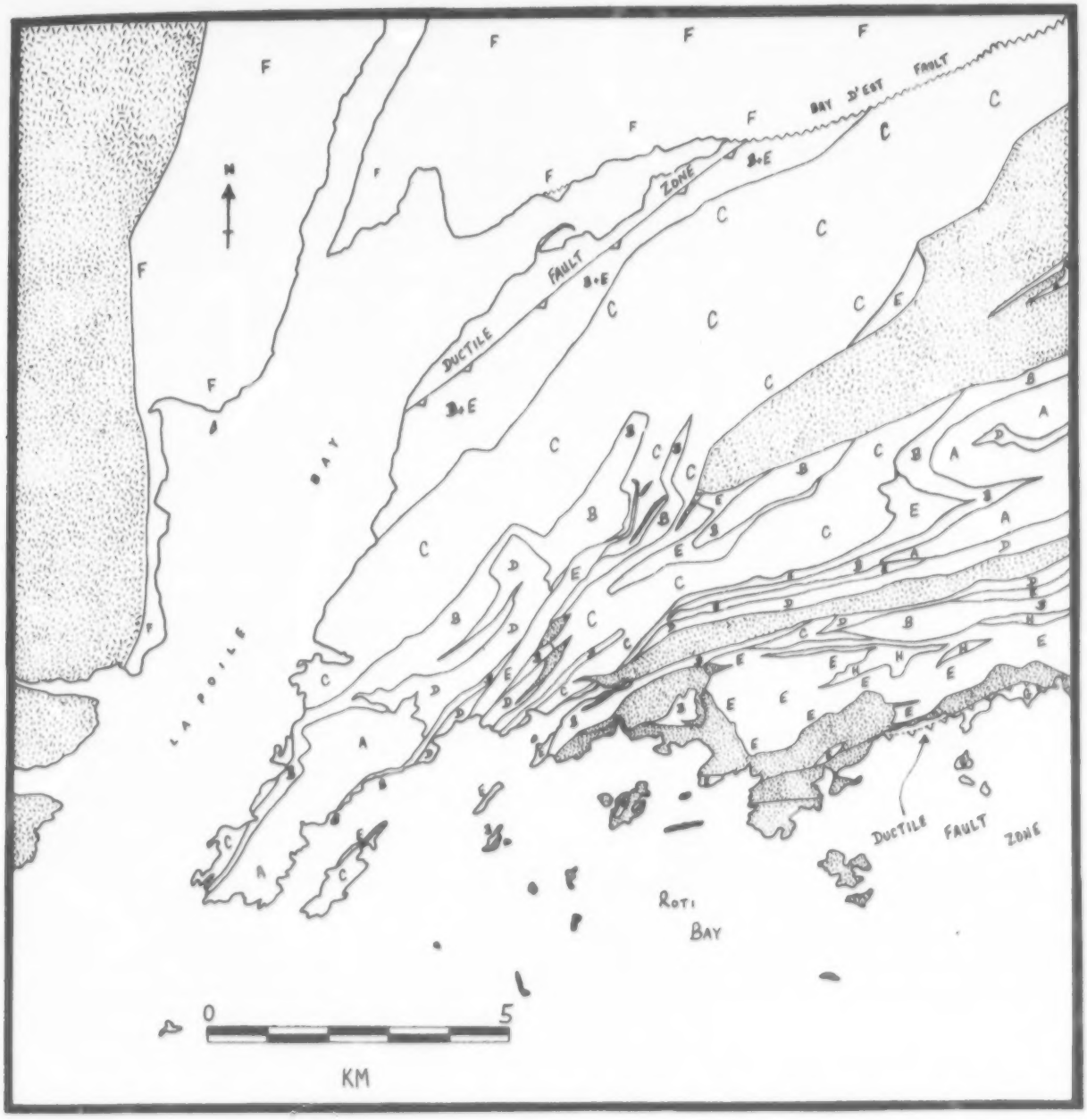
During the 1987 field season, Lower Paleozoic volcanic, sedimentary, metamorphic and plutonic rocks were surveyed in the Roti Bay - La Poile Bay area, and revisions were made to the map of the adjoining Grand Bruit - Cinq Cerf area (Open File Map 86-72).

The La Poile Group of possible Late Silurian age comprises several major lithofacies that commonly recur along and across the tectonic strike of the strata (Figure 1). They are as follows: a) felsic, massive and banded, lava flows and rare ignimbrites, b) felsic agglomerate and lithic tuff, c) quartz-feldspar crystal tuff, d) epiclastic sandstone, argillite, slate and polymictic conglomerate. The La Poile Group also contains a minor bed of limestone and one map unit of mafic agglomerate and lithic tuff. Any particular lithofacies may split where one or two others pinch-out and terminate laterally (Figure 1), and thus the succession of rocks is quite different in parallel cross sections. Regionally, nevertheless, the La Poile Group is homoclinal facing stratigraphically northwestward.

The Bay du Nord Group of probable Early Ordovician age contains formations of sedimentary and volcanic rocks which have been mapped by earlier workers but are not separated in Figure 1. It is not known how the Bay du Nord Group faces in a regional sense with respect to the La Poile Group but, in the map area, the former is everywhere juxtaposed against the latter by the Bay d'Est Fault.

The La Poile Group has been regionally metamorphosed in the greenschist facies and displays the structural characteristics of most slate belts. Like the rocks in many other supracrustal belts, it has been chiefly affected by upright deformations ($D_1$ and $D_2$). The La Poile Group is, however, locally inverted for several kilometres and is also strongly deformed as Early Ordovician or earlier rocks are approached at its faulted northwestern and southeastern boundaries (Figure 1). In contrast, the Bay du Nord Group has been regionally metamorphosed in the amphibolite facies, is isoclinally folded and is, at least in part, tectonically repeated. It shows a transition commonly seen in the infrastructure of thrust and nappe terranes, whereby an early recumbent deformation ($D_1$) is succeeded by a later upright deformation ($D_2$).

In the Roti Bay - La Poile Bay area, map units of intrusive rocks (Figure 1) are emplaced into the La Poile and Bay du Nord groups and are all syntectonic with reference to the regionally upright, $D_2$ deformation. The intrusive bodies are mostly granitoids, however, syntectonic quartz-feldspar porphyries, rhyolites, hornblende gabbros and mafic dykes are also present in the La Poile Group. Immediately east of the map area, there is an occurrence of a probable Lower Devonian, posttectonic pluton, while north of the area, a granitoid intrusive into the Bay du Nord Group is reported to be affected by the regionally recumbent $D_1$ deformation of that group.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Discontinuous stratabound zones of sericitic, pyritic and silicic alteration are present in the Roti Bay - La Poile Bay area and some are associated with gold mineralization. Alteration zones are most commonly found in the La Poile Group, although there is not a unique lithofacies - alteration association within that group. More significantly, syntectonic intrusions within the La Poile and Bay du Nords groups, and fault rocks that separate these groups, are locally affected by alteration characteristic of the stratabound zones and are, therefore, potential hosts to auriferous deposits.

# Preliminary sedimentology and stratigraphy of the Connecting Point Group: 2C/12, 2C/13

by

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Newfoundland Mapping Section

The Connecting Point Group is a thick and aerially extensive succession of Late Precambrian, marine, dominantly clastic rocks that is exposed in a southward-narrowing belt extending from Gooseberry Island, Bonavista Bay to Long Island, Placentia Bay. The group occupies a stratigraphic position conformably above the mainly volcanic Love Cove Group and unconformably beneath the Musgravetown Group.

Our work in the Eastport (2C/12) and St. Brendan's (2C/13) map areas (Figure 1) represents the first systematic, detailed study of the Connecting Point Group in the Bonavista Bay area, where the most complete sections of the group are exposed. Detailed mapping by O'Brien (1987) in the Eastport area resulted in the establishment of the regional stratigraphic position and the stratigraphic subdivision of the group. Continuation of the detailed mapping and logging of sections northward and eastward in 1987 has enabled us to extend and refine these subdivisions, as well as define previously unmapped, regionally extensive facies.

Detailed logging has been carried out on vertical to steeply dipping and overturned sections through part of the group, exposed on the common limb of a major anticlinorium-synclinorium pair. The deepest stratigraphic levels of the group are preserved in this structure. Initial work has been undertaken on the succession exposed on hhe eastern, gentle upright limb of this syncline. A total of ten dis-

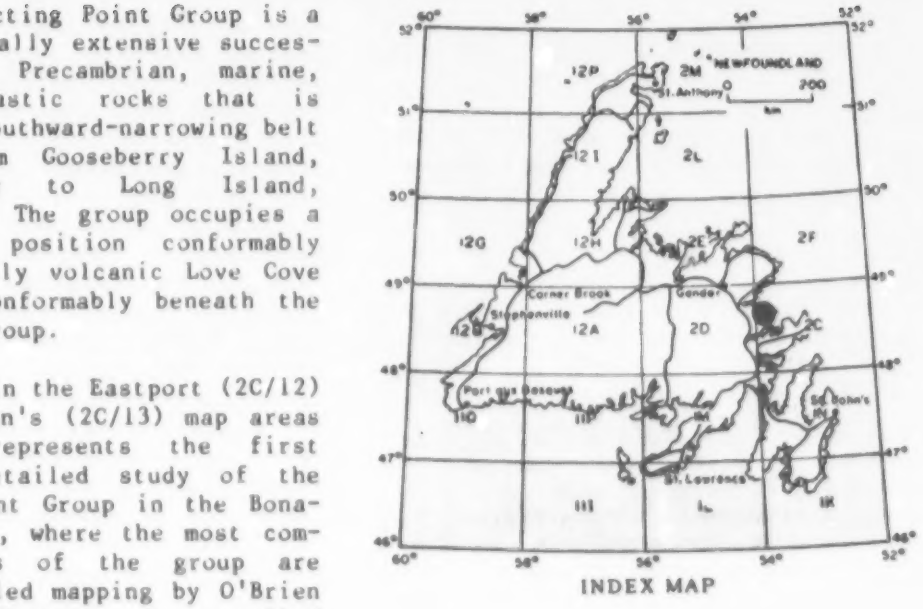


**Figure 1:** Location of study area.

tinctive lithofacies have been recognized within the Connecting Point Group in the study area (Table 1).

The Connecting Point Group is essentially a thick pile of epiclastic, turbiditic sandstone, siltstone, shale and silicified sediment. Black shale and interbedded pyroclastic sedimentary rocks of the Love Cove Group underlie the turbidites and are intercalated in the lower 300 m of the Connecting Point Group.

In the west, the sedimentary rocks of the basal part of the Connecting Point Group form an upward-coarsening stratigraphic succession of at least 2500 m thick. This huge thickness is itself com-

posed of several upward-coarsening megasequences (tens to hundreds of metres) of shale, thin bedded mud to very fine grained sandy rocks, well bedded thin to thick bedded, medium to very fine grained turbidite sandstone, and massive pebbly and intraclastic, granular to coarse grained sandstone. The megasequence in turn consists of 10-m-thick sequences that either coarsen and thicken upward (most common) or fine and thin upward.

These elements and the lithofacies within this lower sequence indicate that the clastic rocks were deposited within a series of prograding deepwater submarine fans marginal to a volcanic upland. A small number of northwestward and southwestward directed paleocurrents (flute and groove casts) and eastward coarsening of the massive sandstone lithofacies, support a source to the east.

In the east, spectacular mixtite deposits are thought to occupy a stratigraphic position equivalent to or slightly younger than the upper part of the above coarsening upward sequence. The restriction of the mixtite to the east of the region further supports an eastern source area.

Shale and chert with common slump folds overlie the mixtite in the east and the coarsening upward sequence in the west. An upper, several thousand metre thick succession (only partly investigated) of upward coarsening megasequences of shale, turbidite sandstone and massive sandstone occurs in the east of the area. These rocks possess the features of classic distal to proximal turbidites, but are for the most part silicified.

Detailed logging and mapping have not yet provided sufficient data to interpret the regional and tectonic setting of the Connecting Point Group. However, this extremely thick succession can be divided into somewhat distinctive assemblages of deepwater submarine fan deposits. The division coincides approximately with the succession just stratigraphically above and below the mixtite. This stratigraphic interval in the area northeast of Eastport is also host to a swarm of diabase dykes which intruded the sediments whilst they were still soft. Small compositionally similar mafic plutons also occur in the same area. The presence of pebble- to block-size detritus of silicic volcanic rocks, and diabase in the mixtites to the northeast of Eastport and Salvage, suggests that basin extension was accompanied by intrusion of basic dykes and small plutons, coincident with uplift of a silicic pyroclastic source area. The evidence of this extension and uplift, plus the extremely thick succession of the basin, hints that it may have evolved by extension in a pull-apart wrench setting.

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O'Brien, S.J.
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**Table 1:** Sedimentary lithofacies of the Connecting Point and Love Cove groups, Bonavista Bay

| LITHOFACIES | CHARACTERISTIC FEATURES | ENVIRONMENT |
|---|---|---|
| 1 SHALE | 1A: Grey to black, containing silicic laminae, thin chert beds and fine grained tuffs. | Quiet basinal |
| | 1B: Grey to black shales and lensoid and cross-laminated siltstones. | Slope deposits, distal turbidites |
| 2 PYROCLASTIC SEDIMENTS AND TUFFITES | Fine grained, schistose, locally auriferous, vitric tuff, quartz crystal tuff, lithic tuff and agglomerate; displays crude coarsening upward. | Associated with shales - quiet basinal setting |
| 3 COLOR BANDED SILTSTONE - SHALE FACIES | Green-grey, laminated and planar-bedded siltstone interbedded sharply with blue-grey shale. | Slope sediments distal turbidites |
| 4 THIN BEDDED SILICEOUS ARGILLITE/SILTSTONE AND SHALE | Planar, thin, laminated, cross-laminated and locally convoluted beds; fissure cracks; frequently intercalated with massive sandstone. | Distal turbidites or locally abandoned fan lobe channel |
| 5 THIN BEDDED VERY FINE SANDSTONE, SILTSTONE AND SHALE | 5A: Centimeter-scale, laminated or cross-laminated sandstone and siltstone, sharply interbedded with shale; some cross-laminated, 15-30 cm, very fine sandstone at base of fining upward sequences up to 15 m thick; rare scours. | Distal levee |
| | 5B: Similar to 5A but with frequent small scale slump folds, faults, and convolution; associated with tongues of massive sandstone, and laterally with massive sandstone sequences. | Near channel levee |
| 6 BEDDED TUFFACEOUS SANDSTONE - SHALE<br><br>(in crude to well developed coarsening upward and fining upward sequences) | 6A: Metre-thick sequences of planar-bedded, thin to medium-bedded, medium to very fine grained sandstone; generally structureless, but with some parallel lamination; sharp or gradational top with shale. | Mid fans and fan lobe turbidites |
| | 6B: Cross-laminated and convoluted, very fine grained sandstone and shale. | Outer fan turbidites |

Table 1 (Concluded)

| | | |
|---|---|---|
| 7 THICK BEDDED SANDSTONE AND MASSIVE PEBBLY SANDSTONE; RARELY CONGLOMERATE | 7A: Thick bedded, structureless sandstone, some amalgamated beds; contains intraclasts; graded from very coarse to fine grained. | Proximal turbidites and fan lobe channels |
| | 7B: Amalgamated, scoured, meter-thick beds of very coarse grained to granular sandstone; massive to planar-stratified, rarely crossbedded, cross-laminated, convoluted. | Fan lobe channels |
| 8 GRADED PLANAR-STRATIFIED SANDSTONE, SILTSTONE AND SHALE | Planar stratification throughout; fining upward with intraclasts at base; locally convoluted and commonly interbedded in shale. | Crevasse splay, bipass fan lobe |
| 9 MIXTITE | Pebble- to block-sized sedimentary lithoclasts (especially of facies 4 to 6) plus rare to locally abundant mafic to felsic volcanic detritus, folded blocks; chaotic to oriented fabric; matrix of granular to sandy mudstone; associated with facies 7B, and slump-folded sediments above; areally extensive in east of area. | Inner channel deposit, olistostrome |
| 10 BEDDED CHERTS AND SILICEOUS ARGILLITE | White to grey and black, stratified; units are thick, and locally preserve original sedimentary structure; slump folds are common. | Diagenetic for most part |

Note: Lithofacies 1A occurs exclusively in the Love Cove Group. Lithofacies 2 is found in both Love Cove and Connecting Point groups. All other lithofacies occur within the Connecting Point Group.

# Geology and structural relationships of the Cutwell Group, western Notre Dame Bay

by

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This report summarizes the results of field studies directed toward the stratigraphic, structural and paleotectonic setting of volcanic rocks and related mineral deposits within the Early to Middle Ordovician Cutwell Group (Figure 1). Rocks of this group are exposed north of the Lobster Cove Fault on Triton, Pilley's, Long and Little Bay islands and several smaller islands and headlands in western Notre Dame Bay.

The Cutwell Group consists dominantly of mafic to intermediate and lesser silicic volcanic rocks. It has been considered (e.g., Dean, 1978) to be the only volcanic sequence in western Notre Dame Bay to traverse the Caradocian shale, including both pre- and post-Caradocian volcanic rocks.

Several thesis studies focused on this area during the late 1960's and early 1970's (e.g., Donohoe, 1968; Kean, 1973; O'Brien, 1975). Additional data are provided by extensive exploration work by Brinex and Getty during the late 1970's and early 1980's.

The main observations resulting from the 1987 field season are as follows:

1) Rocks of the Cutwell Group on Long, Little Bay, Triton and Pilley's islands and on Halls Bay Head, display complex internal structure, dominated by northwestward-verging folds and northwestward-directed thrust faulting; duplexes were recognized in the area of Triton, Long and Pilley's islands.

2) The kinematic indicators along the Lobster Cove Fault, which forms the southern boundary of the Cutwell Group and was previously interpreted as a southeastward-directed thrust fault (Dean and Strong, 1977), imply dextral, strike-slip movement. No structural evidence was seen that would indicate thrusting on this fault.

3) Rocks of the Long Tickle formation in the southern part of Long Island, previously thought to be post-Caradocian in age, are lithologically similar to the pre-Caradocian Burnt Head formation. Both formations are overlain by felsic rocks of the Seal Cove complex. It is believed that the Long Tickle formation is also pre-Caradocian in age, faulted against the Caradocian shales in Lushs Bight which are the youngest strata in the area.

4) Sulphide mineralization on Long Island (the Shamrock and Oil Islands prospects), hosted by the Long Tickle formation, are now considered to be pre-Caradocian in age, and do not represent an anomalously (with respect to the rest of Notre Dame Bay) young volcanogenic mineralization episode.

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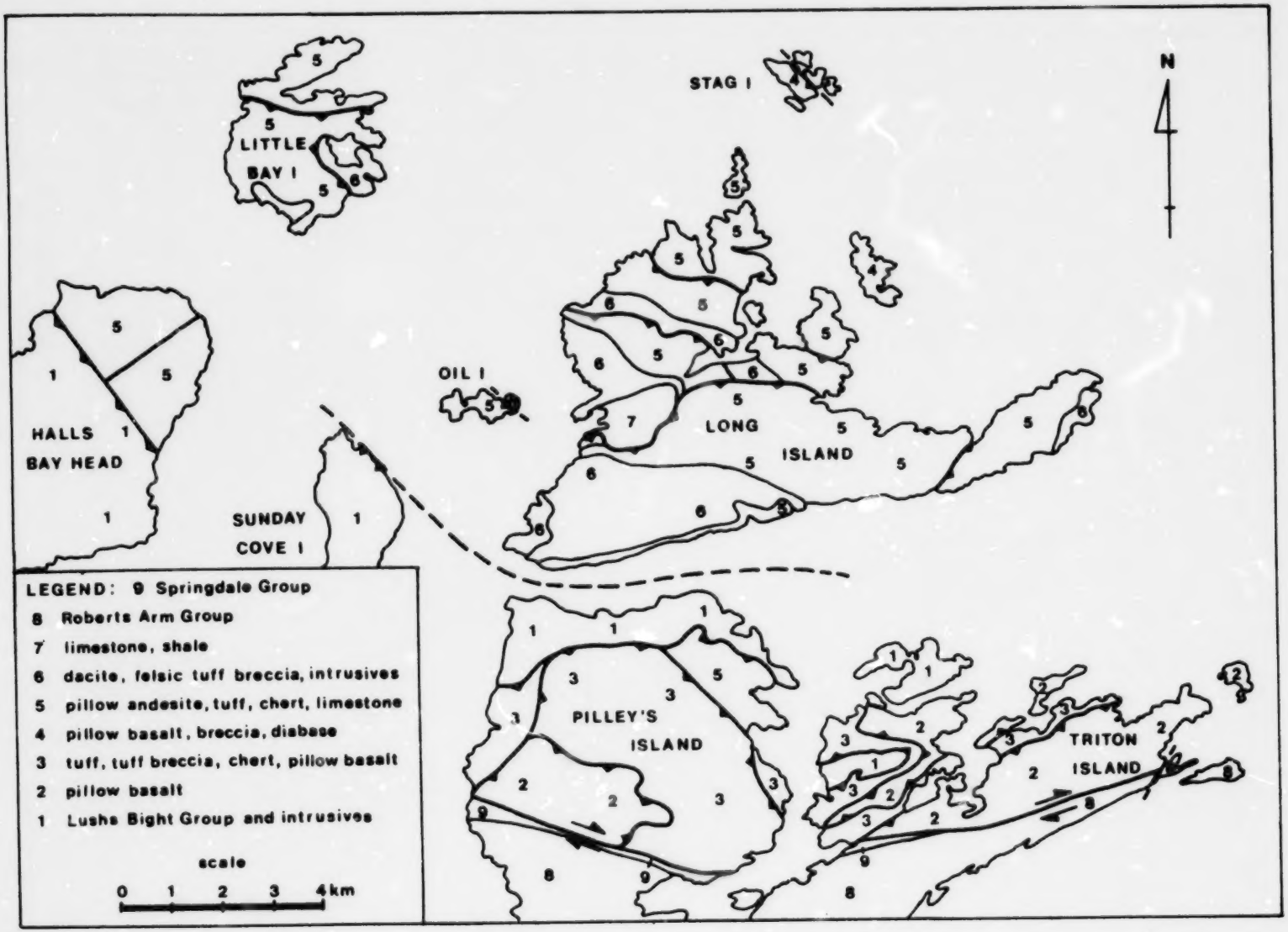


**Figure 1:** Geology of the Cutwell Group.

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1968: The structure and stratigraphy of the Halls Bay Head area, Notre Dame Bay, Newfoundland. Unpublished M.Sc. thesis, Lehigh University, 84 pages.

Kean, B.F.
1973: Stratigraphy, petrology and geochemistry of volcanic rocks of Long Island, Newfoundland. Unpublished M.Sc. thesis, Memorial University of Newfoundland, 155 pages.

O'Brien, S.J.
1975: The stratigraphy, petrology and geochemistry of the extrusive and intrusive rocks of Little Bay Island, Newfoundland. Unpublished B.Sc. thesis, Memorial University of Newfoundland, 64 pages.

# GEOCHEMISTRY/GEOPHYSICS

# Geochemistry and geology of auriferous environments in the Ashuanipi Metamorphic Complex, Labrador

by

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Geochemistry and Geophysics Section

## Introduction

The discovery of gold mineralization in Archean rocks of the Ashuanipi Complex (Lapointe, 1986) 70 km northwest of Schefferville in Quebec has led to considerable exploration activity in the area (Figure 1). Work on the Labrador portion of the complex in 1986 by Thomas and Butler (1987) identified several areas with above average abundances of gold in bedrock. They had selected areas for study that had anomalously high concentrations of possible gold pathfinder elements including As, Ag, Cu, Hg, Mo and Zn in reconnaissance lake sediment samples (Geological Survey of Canada, 1982a,b). Recent detailed work by Butler (1987) indicated locally high contents of gold in lake sediment. Geological mapping at 1:250,000 scale of the northern half of the complex by Percival (1987) also recognized auriferous zones.

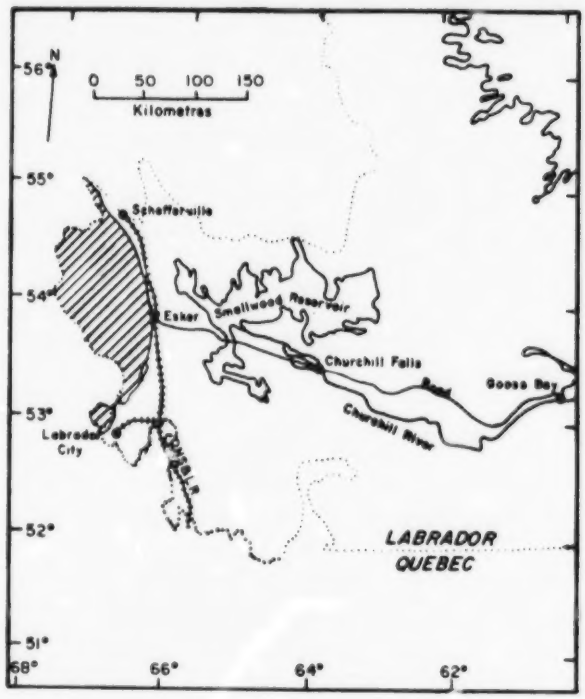


**Figure 1:** Location of Ashuanipi Complex.

## Present Investigation

Our field work during 1987 exploited results of the previous work and focused primarily on 18 areas in which Butler's data had disclosed anomalous contents of gold in lake sediment or where Thomas or Percival had found indications of gold in bedrock (Figure 2). Our aim was to apply geochemical exploration methods to understand the nature of the distribution of gold and gold pathfinder elements in the surficial and bedrock environments. Approaches included soil and stream sediment sampling as well as bedrock mapping and sampling. In addition, 621 samples of lake sediment were collected at a high-sampling density (1 sample per 2.7 km2) in areas identified from the reconnaissance lake sediment data as having high contents of gold sympathetic elements (Figure 2). Analyses of the lake sediments may provide the exploration industry with additional gold ± base-metal targets.

## Preliminary Results

Several sulphide-bearing occurrences, ranging from approximately 4 cm across to over 1 km in strike length, were discovered during the sampling and mapping project. Of 180

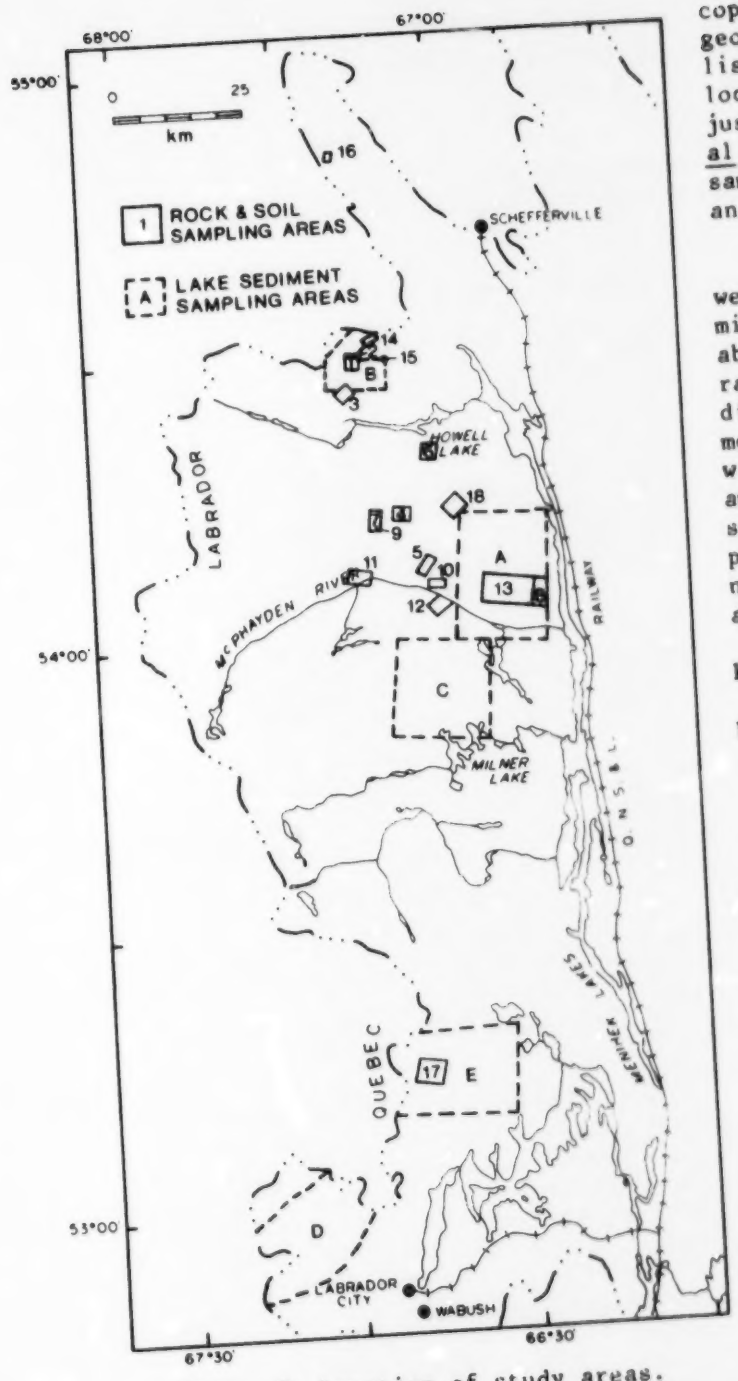


**Figure 2:** Location of study areas.

rock analyses, seven equal or exceed 100 ppb Au (Table 1). The highest analysis, 1875 ppb Au, is a grab sample from a paragneiss with 1 to 2 percent pyrite and traces of chalcopyrite. A report describing the geology of the areas in detail and listing the gold analyses and locations of all rock samples has just been published (McConnell et al., 1987). Analyses of surficial samples will be released in 1988 as an open file report.

Eleven of the 18 detailed areas were mapped. All are underlain by migmatized gneiss and younger variably deformed intrusions. Most rocks range in composition from granodiorite to tonalite. Granulite grade metamorphism is found throughout, with lesser occurrences of upper amphibolite grade rocks in the south. Rocks in the south of the complex, associated with thrust faulting near the Grenville Front, are variably retrograded.

## References

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1982a: Regional lake sediment and water geochemistry reconnaissance data, NTS 23G, Labrador. Geological Survey of Canada, Open File 903.

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1986: Reconnaissance geologique de la region du lac Pailleraut, Territoire du Nouveau Quebec. Ministere de l'Energie et des Resources, Gouvernement du Quebec, MB85-73, 11 pages.

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1987: Bedrock gold analyses and geology of metalliferous areas of the Ashuanipi Complex, western Labrador. Newfoundland Department of Mines, Mineral Development Division, Open File Lab. 735.

Percival, J.
1987: Geology of the Ashuanipi granulite complex in the Schefferville area, Quebec/ Labrador. In Current Research, Part A. Geological Survey of Canada, Paper 87-1A.

Thomas, A. and Butler, J.
1987: Gold reconnaissance in the Archean Ashuanipi Complex of western Labrador. In Current Research. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 87-1, pages 237-244.

Table 1: Rock analyses equal or greater than 100 ppb Au.

| Sample No. | Grid | NTS Map | Easting | Northing | Rock Description | Au ppb |
|---|---|---|---|---|---|---|
| 4440007 | 1 | 23J/11 | 617300 | 6046550 | plag-bio-pyx, tr py | 100 |
| 4440013 | 1 | 23J/11 | 618450 | 6045700 | plag-bio-pyx, 1% py | 515 |
| 4440055 | 1 | 23J/11 | 617825 | 6044900 | plag-cpx, 1% py | 130 |
| 4440057 | 3 | 23J/11 | 615900 | 6040375 | silic-pyx-bio-plag, 1-2% py | 1875 |
| 4440099 | 9 | 23J/3 | 624020 | 6012920 | bio-plag-qz, 1-2%, py, trace cp | 400 |
| 4440109 | 7 | 23J/6 | 620650 | 6020150 | plag-bio gneiss, 10% py | 550 |
| 4440155 | 9 | 23J/3 | 623980 | 6012920 | silicified-bio-plag gneiss, 10% py | 100 |

# Datafiles Management

by

James Butler
Geochemistry and Geophysics Section

Since 1972, with the initiation of the Federal - Provincial geoscience programs, a large volume of geochemical data has been collected for various projects. These data include the field and analytical data from the lake sediment, stream sediment, soil and till sampling programs, as well as from the granite sampling program and from numerous other projects including sampling of volcanic and sedimentary rocks. These have been keyed and, after the initial open file release of the information, are presently stored on tape at the Newfoundland and Labrador Computer Services facilities.

To make these data more accessible and usable, a database manager was appointed to compile and standardize the data and make it available to the public on either magnetic tape or floppy disks. The initial concept is for the field geologists to submit their field and analytical data to the Database Manager who would arrange to have it keyed and then run the data through a series of editing programs to pick up glaring errors; plot the data so that the geologists can check sample locations; and prepare a standard report which would include summary statistics of the analytical data for checking by the project geologist. The data would then, when the project geologist has completed his/her initial work, be incorporated into a comprehensive file with a standard format, variable names and value labels. It would be then made accessible to outside users.

To date, a start has been made on this approach to the granite sample data. Several data sets have been cleaned and the variable names standardized. In the near future it is hoped that a working copy of a comprehensive granite file will be available. It will be the responsibility of the project geologist to inform the Database Manager of any errors in the data so the latter can correct the master file.

A list of the standard granite file variable names, their formats and their value labels, with the format, is given in Table 1. Any suggestions or comments for improvements will be seriously considered and appreciated.

Table 1: List of variables to be used on the granite files

| FORMAT | ROCK TYPE | VALUE LABEL |
|---|---|---|
| F7.0 | LABNUM | Lab number (same as sample number) |
| A (7) | FIELDNUM | field sample number |
| F2.0 | ZONE | UTM zone number |
| F6.0 | UTMEAST | UTM easting (m) |
| F7.0 | UTMNORTH | UTM northing (m) |
| A (3) | NTS1 | NTS primary and lettered quadrangles 1:250 |
| F2.0 | NTS2 | NTS numbered quadrangle 1:50 |
| A (4) | ROCKTYPE | rock type |
| F2.0 | ROCKAGE | age of rock |
| F1.0 | SAMPLTYPE | sample type |
| F1.0 | COLOUR | sample colour |
| F1.0 | GRAINSIZ | sample grain size |
| F1.0 | TEXTURE | sample texture |
| F1.0 | FABRIC | sample fabric |
| F1.0 | PRIMBAND | primary banding |
| F1.0 | ALTER | sampler alteration |
| F1.0 | FELDALT | feldspar alteration |
| F1.0 | MEGACRYS | megacrysts present |
| F1.0 | HORNBLEN | hornblende present |
| F1.0 | BIOTITE | biotite present |
| F1.0 | SULPHIDE | sulphide content |
| F1.0 | GARNET | garnet |
| F1.0 | TOURMAL | tourmaline |
| F1.0 | BERYL | beryl |
| F1.0 | FLUORITE | fluorite |
| F1.0 | MUSCOVIT | primary muscovite |
| F3.0 | PLUTONUM | pluton number |
| F2.0 | REPLNUM | replicate sample number |
| F7.0 | SPORIGNO | original sample number of analytical split |
| F1.0 | SPLIT | whether sample has been split |
| F2.0 | UNIT | unit number (division of pluton no.) |
| F1.0 | PLOTLOC | sample number plot location |
| F4.2 | SIO2 | percent |
| F4.2 | AL2O3 | percent |
| F4.2 | FE2O3 | total Fe percent |
| F4.2 | FEO | percent |
| F4.2 | MGO | percent |
| F4.2 | CAO | percent |
| F4.2 | NA2O | percent |
| F4.2 | K2O | percent |
| F3.2 | TIO2 | percent |
| F3.2 | MNO | percent |
| F3.2 | P2O5 | percent |
| F3.2 | H2O | percent |
| F4.2 | S | percent |
| F4.2 | CO2 | percent |
| F4.2 | LOI | percent (organic content) |
| F5.2 | TOTAL | total content of major elements |
| F5.2 | CALTOTAL | calculated total of major elements |
| F6.0 | BA | barium g/t |

Table 1 (Concluded)

| FORMAT | NAME | VALUE LABEL |
|---|---|---|
| F6.0 | CU | copper g/t |
| F6.0 | CU | copper g/t |
| F6.0 | PB | lead g/t |
| F6.0 | SR | strontium g/t |
| F5.0 | NI | nickel g/t |
| F5.0 | LI | lithium g/t |
| F4.0 | RB | rubidium g/t |
| F4.0 | CR | chromium g/t |
| F4.0 | V | vanadium g/t |
| F4.1 | BE | beryllium g/t |
| F4.0 | MO | molybdenum g/t |
| F4.0 | CO | cobalt g/t |
| F3.1 | AG | silver g/t |
| F5.0 | F | fluoring g/t |
| F5.1 | W | tungsten g/t |
| F5.1 | SN | tin g/t |
| F5.1 | U | uranium g/t |
| F4.0 | GA | gallium g/T |
| F4.0 | NB | niobium g/t |
| F4.0 | ZR | zirconium g/t |
| F4.0 | TH | thorium g/t |
| F4.0 | Y | yttrium g/t |
| F4.0 | LA | lanthanum g/t |
| F4.0 | CE | cerium g/t |
| F4.0 | BI | bismuth g/t |
| F4.0 | HG | mercury mg/t |

(Use standard chemical symbols for elements not listed.)

# Geophysical investigations in central Newfoundland

by

Gerry Kilfoil
Geochemistry and Geophysics Section

Three areas of recent active mapping in central Newfoundland were investigated by combined magnetic and VLF ground surveys oriented perpendicular to strike. Survey locations are displayed in Figure 1.

## Area 1

Surveys were conducted across units of the Gander River Ultrabasic Belt (GRUB) within the northwest corner of Weir's Pond (2E/1) map area and into the Carmanville (2E/8) map area to the north. The objective was to geophysically characterize units of the GRUB and trace its northeastward extension into the Carmanville map area with emphasis on the nature of the contact with the Gander Group to the southeast. The high aeromagnetic anomaly associated with the rocks of the GRUB ends near the boundary between the two map areas.

An ultramafic rock unit constitutes the easternmost part of the GRUB north of Weir's Pond and can be mapped northward by its high magnetic signature. Mafic volcanic rocks are characterized by intermediate magnetic values, and separate ultramafic rocks from sedimentary rocks containing graphite-rich shale, the whole of which appears to be repeated in structural slices across the breadth of the GRUB.

In the Carmanville map area, the GRUB consists primarily of deformed sediments with ankerite and magnesite units, all of which have low magnetic susceptibility. Deformation increases with proximity to the Gander Group/GRUB contact zone. Small lenses of ultramafic rocks, scattered within GRUB units near the contact zone, have areally small but very strong magnetic anomalies. The strongest anomaly recorded is associated with a small, newly discovered, serpentinite body. Another body, not found in outcrop, was detected flanking a large outcrop of magnesite. Units comprising the GRUB in the Carmanville map area appear to be metamorphosed equivalents of units to the south.

## Area 2

A northeast-oriented belt of ultramafic outcrops located in the Mount Sylvester (2D/3) map area was surveyed with traverses 1 to 4 km long and spaced on the order of 0.5 km. Ultramafic rocks were bracketed by lines extending from non-magnetic sandstone and siltstone in the northwest to within units of low magnetic signature in the southeast.

Magnetic anomalies were largest and most variable in profiles positioned directly over chromite-bearing ultramafic outcrops. Values along traverses reach their maxima just southeast and adjacent to the ultramafic "front" or northwest boundary of ultramafics. The shapes of profiles relative to the outcrop pattern suggest that the magnetic ultramafic units dip at 45 to 60 degrees to the southeast. In certain non-outcrop localities, the front was only weakly detected as low smooth anomalies, indicating the extension of ultramafic bodies at significant depths beneath low magnetic units and explaining the apparent periodic pinching out of aeromagnetic anomalies.

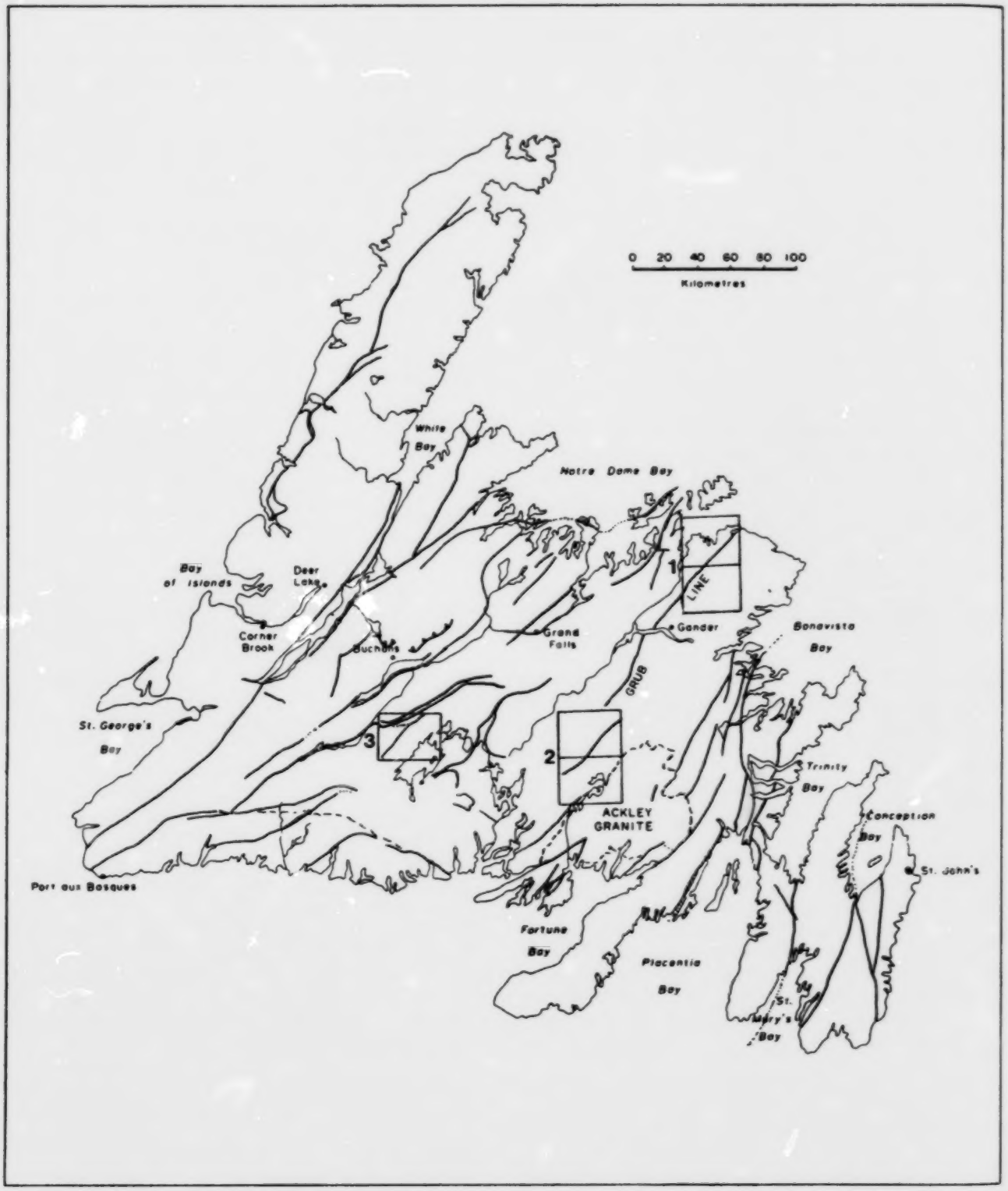


**Figure 1:** Locations in central Newfoundland of geophysical surveys carried out during the 1987 field season. Major faults and lineaments are added for reference.

The front edge was observed to be offset to the southeast at intervals along the belt's length. On several traverses, the anomaly at the front is paralleled by a second anomaly to the southeast whose magnitude varies with locality from very weak to greater than that near the front. Collectively, recorded anomalies give the appearance of a series of thrust sheets arranged in an "en echelon" pattern or a single thrusted body with the thrust front running oblique to ultramafic layers within the body. The ultramafic belt is separated into two mappable thrusts within the Great Gull Lake (2D/6) map area to the north (Blackwood, 1983).

## Area 3

An attempt, in the Snowshoe Pond (12A/7) map area, to trace boundaries of lithologic units and major shear zones through drift- and vegetation-covered areas was met with mixed success. A major change in strike from northeast to nearly east that occurs southwest of Lake Douglas and two mapped shear zones that converge at Noel Paul's Brook were of particular interest. The shear zones, not strongly expressed in the VLF data, are considered to be dry (devoid of conducting fluids) or without conductive mineral concentrations.

To the southeast of the shear zones, a series of anomalies form an arcuate string curving from a northeastward to a westward trend. The pattern suggests the presence of mafic-rich rocks at shallow depth, brought to the near surface by thrust faulting, but no mafic rocks have been observed at surface. Consequently, Unit 1 may represent a structurally repeated sequence. This belt of magnetic highs is only faintly expressed on older aeromagnetic maps (Geological Survey of Canada, 1968) but well defined on recent aeromagnetic data (Geological Survey of Canada, 1985).

The boundary between quartzites and pelites of Unit 1 and mafic-rich clastics and volcanics of Unit 11 was followed westward from the Granite Lake road to Wilding Lake by its strong magnetic signature. A small, but very anomalous, magnetic body was defined near the boundary, just east of Wilding Lake. The high magnetic values indicate ultramafic rocks, with implications that the boundary is a thrust. A similar aeromagnetic anomaly, located along strike just west of Wilding Lake, was not investigated on the ground.

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Geological Survey of Canada
1968: Red Indian Lake, Newfoundland, Sheet 12A. Geological Survey of Canada, Aeromagnetic series, Map 7049G.

1985: Aeromagnetic total field map, Showshoe Pond, Newfoundland, scale 1:50,000. Geophysical Series, Map C21141G.

# Increasing the usefulness of lake sediment geochemistry to mineral exploration

by

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The geochemistry of organic lake sediment was first employed in Newfoundland on a regional scale for base-metal exploration (Davenport et al., 1975), after orientation studies had been done over several base-metal prospects (Cominco, 1970; Hornbrook et al., 1975). Uranium in lake sediment was later applied successfully to regional exploration for this metal across Canada (Coker et al., 1979). For the past several years prices of base metals and uranium have been depressed, and exploration interest has focused on Au and other precious metals. There is also interest in the market potential of metals such as Be, Ga, Y, Ge, Zr, Nb and the rare-earth elements.

The existing suite of Cu, Pb, Zn, Co, Ni, Ag, Mo, U, F together with Mn, Fe and organic carbon content, which reflect the lacustrine environment, are not particularly relevant to metals currently of exploration interest, although in some cases they can be used as pathfinder elements. The developments in analytical chemistry over the past decade, particularly in the field of inductively coupled plasma atomic-emission spectroscopy (ICP-AES) and instrumental neutron-activation analysis (INAA), allow the measurement of the abundances of most elements in geological materials accurately and cheaply. They also provide the opportunity for expanding the element suite on archived regional geochemical samples to include many of the elements of current exploration interest.

The modes of transport of metals from a mineral deposit into organic lake sediment is not well understood. It is assumed that both ground water and surface water have a role, but the details of solution, nature of the metal species in solution, and metal fixation in lake sediment are poorly known. These aspects will, no doubt, be clarified in due course by research, but the effectiveness of organic lake sediment geochemistry in reflecting the presence of deposits of elements such as Au or the rare earths can be addressed more pragmatically through orientation studies similar to those done in the original evaluation of the effectiveness of the sample medium for base-metal and U exploration.

The first step in evaluating the usefulness of elements, such as Au and Be, in lake sediment is to establish typical abundances for these elements in this medium, and to determine whether the available, rapid, analytical methods can determine these abundances adequately. For example the range of values of Au in lake sediment in Newfoundland from about 1500 sites is less than 1 to 100 mg/t, with an average value of less than 1 mg/t. The INAA method has a detection limit of about 2 mg/t Au based on a sample weight of 5 to 10 g, so this method can measure only high background to anomalous values. In the case of Br, the range of abundance is 1.5 to 160 g/t, with an average value of about 55 g/t. Here the INAA method, with a detection limit of about 1 g/t, is able to quantify Br over its entire range in lake sediment. For other elements the methods which are currently available at reasonable cost (i.e., about 50 cents or less per determination) have

detection limits that are too high to determine their abundance in lake sediment at all.

An evaluation of which elements in a multi-element INAA suite have sufficiently low limits of detection to be useful in the analysis of lake sediment is shown in Table 1. These data were from Becquerel Laboratories Inc. For some elements which are rated as poor or useless by INAA, alternative, cheap methods are available, e.g., atomic-absorption spectrophotometry for Cd, whereas for others there may be at present no obvious method.

Having found an appropriate analytical method, the next, equally important, step is to determine how the lake sediment geochemical patterns reflect bedrock geochemical patterns. For Au, the results of orientation studies over several Au prospects (McConnell 1985, 1987) and the results from reconnaissance samples collected at a density of 1 site per 6 km2 (Davenport and Nolan, 1987) show that, indeed, Au in lake sediment is a reasonably effective technique of assessing and delineating the Au potential of a region, and that pathfinder elements such as Sb, As, and Se can distinguish between different types of Au mineralization.

The Strange Lake Zr-Y-Nb-Be-REE deposit in Labrador has afforded the chance to evaluate the dispersion characteristics in organic lake sediment of a number of these elements. The initial anomaly that led to the deposits discovery in 1979 resulted from a Pb-U anomaly in lake sediment, accompanied by F in lake waters - none of these elements is an ore element. McConnell and Batterson (1987) have shown that Be in lake sediment shows the dispersion pattern well, and Th and the heavy rare-earth elements Tb, Yb and Lu are also effective (McConnell, personal communication, 1987). Work is in progress to determine the dispersion pattern in lake sediment of Y, Zr and Nb, using ICP-AES as the analytical method.

The Granite Lake area of central Newfoundland contains widespread W-Mo mineralization (Tuach and Delaney, 1987), the discovery of which resulted from follow-up exploration by mining companies of an Mo, Pb, Zn, Cu, Ag reconnaissance lake sediment anomaly. The W mineralization was also shown to be reflected by anomalous W values in lake sediment (Davenport and Butler, 1982), W being determined in that study by a rather slow and expensive colorimetric method. The W results from the INAA suite correlate well with the older colorimetric data, and therefore W in lake sediment is effective in delineating areas of W mineralization.

Studies are continuing to determine how well the distribution in lake sediment of other elements correspond to their distribution in bedrock and,in particular, how well they reflect areas of mineralization. In addition the aspect of how variations in the major constituents of lake sediment affect the levels of trace elements is being studied. Up to now Mn, Fe and LOI have been used to monitor variations in lake sediment type caused by the lacustrine environment. The effect of these variables on the less familiar elements now available is being addressed, and the relationships between other major constituents (e.g., Na, Mg, Al, K and Ca) and trace elements are being studied.

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Table 1. A summary of the utility of multi-element neutron-activation analysis (INAA) data for lake sediment samples (data from Becquerel Laboratories Inc.)

| | Quoted Detection Limit | Actual Detection Limit | Abundance in the Lake Sediments Analysed | | Assessment of Data Usefulness |
|---|---|---|---|---|---|
| | | | range | mean | |
| Au | 1 ppb | 2-3 ppb | <1-24 ppb | 1.9 ppb | fair to poor; anomalous values ( >4-5 ppb) can be quantified |
| Sb | 0.05 ppm | 0.1 ppm | <0.05-1.9 ppm | 0.21 ppm | fair; a lower real detection limit would improve the data |
| As | 0.2 ppm | 0.5 ppm | <0.2-228 ppm | 27 ppm | good |
| Ba | 20 ppm | 50 ppm | <20-1200 ppm | 219 ppm | good |
| Br | 1 ppm | 1 ppm | 1.8-161 ppm | 49 ppm | good |
| Cd | 2 ppm | ? 2 ppm | <2-9.1 ppm | - | poor; detection limit 10 times too high |
| Ce | 3 ppm | 3 ppm | 4.8-608 ppm | 102 ppm | good |
| Co | 2 ppm | 2 ppm | <2-140 ppm | 17 ppm | good |
| Cs | 0.5 ppm | 0.5 ppm | <0.5-12 ppm | 1.6 ppm | good |
| Cr | 2 ppm | 15 ppm | <2-393 ppm | 47 ppm | fair; a lower detection limit would improve the data |
| Eu | 0.2 ppm | 0.5 ppm | <0.2-5.3 ppm | 1.2 ppm | fair; a lower detection limit would improve the data |
| Fe | 0.1% | 0.1% or lower | <0.1-15.6 % | 3.1 % | good |
| Hf | 0.5 ppm | 1 ppm | <0.5-23 ppm | 2.7 % | good |
| Hg | 1 ppm | ? | <1 ppm | - | useless; the detection limit is about 100 times too high |
| Ir | 20 ppb | ? | <20 ppb | - | useless; the detection limit is far too high |
| La | 1 ppm | 1 ppm | 5.7-304 ppm | 44 ppm | good |
| Lu | 0.05 ppm | 0.05 ppm | <0.05-3.5 ppm | 0.4 ppm | good |
| Mo | 0.5 ppm | 5 ppm | <0.5-264 ppm | 8.4 ppm | fair; a lower real detection limit would improve the data |
| Ni | 5 ppm | 10 ppm | <5-250 ppm | 24 ppm | fair; a lower real detection limit would improve the data |
| Rb | 5 ppm | 5 ppm | <5-170 ppm | 27 ppm | good |
| Sm | 0.1 ppm | 0.1 ppm | 0.34-53 ppm | 7.3 ppm | good; two noisy controls |
| Sc | 0.1 ppm | ? 0.1 ppm | 0.7-22.1 ppm | 7.2 ppm | good |
| Se | 1 ppm | ? 3-5 ppm | <1-6.5 ppm | 1.2 ppm | poor; a lower real detection limit would improve the data |
| Ag | 1 ppm | ? 1 ppm | <0.2-3 ppm | - | useless; the detection limit is about 20 times too high |
| Na | 0.05 % | 0.05% | <0.05-4.00 % | 0.62% | good |
| Ta | 0.2 ppm | 0.2-0.3 ppm | <0.2-3.5 ppm | 0.41 ppm | good |
| Te | 10 ppm | ? | <10 ppm | 10 ppm | useless; the detection limit is far too high |
| Tb | 0.5 ppm | 0.5 ppm | <0.5-9.3 ppm | 1.1 ppm | good |
| Th | 0.1 ppm | 0.1 ppm | 0.68-41.5 ppm | 7.6 ppm | good |
| Sn | 50 ppm | ? | <50 ppm | - | useless; the detection limit is far too high |
| U | 0.1 ppm | 0.1 ppm | <0.1-180 ppm | 13.5 ppm | good |
| W | 0.5 ppm | 2 ppm | <0.5-67.4 ppm | 2.2 ppm | fair; anomalous values ( >5 ppm) can be reproduced |
| Yb | 0.1 ppm | 0.5 ppm | <0.1-27.3 ppm | 2.1 ppm | good; precision falls off rapidly below 1 ppm |
| Zn | 50 ppm | 75 ppm | <50-440 ppm | 97 ppm | fair to good; detection limit a little high |
| Zr | 50 ppm | 250 ppm | <50-1100 ppm | 173 ppm | fair to good; real detection limit about 5 times too high |

# QUATERNARY GEOLOGY

# Quaternary mapping in the Moran Lake (13K/7 and 13K/10) area, Central Mineral Belt, Labrador

by

Martin J. Batterson
Quaternary Geology Section

## Introduction

This project is designed to assist the mineral exploration industry in areas of extensive glacial cover by providing data on the direction, distance and pattern of glacial transport, the types of glacigenic sediment and their usefulness in mineral exploration programs plus an understanding of the surficial terrain.

This project, a continuation of the 1986 mapping program that centred around Melody Lake (NTS areas 13K/9 and 13J/12), concentrated on the Moran Lake area (NTS areas 13K/7 and 13K/10) (Figure 1). The Moran Lake area has been the focus of significant mineral exploration activity since the 1950's. Uranium has been the element of most interest, although base metals and platinum-group elements may be locally significant.

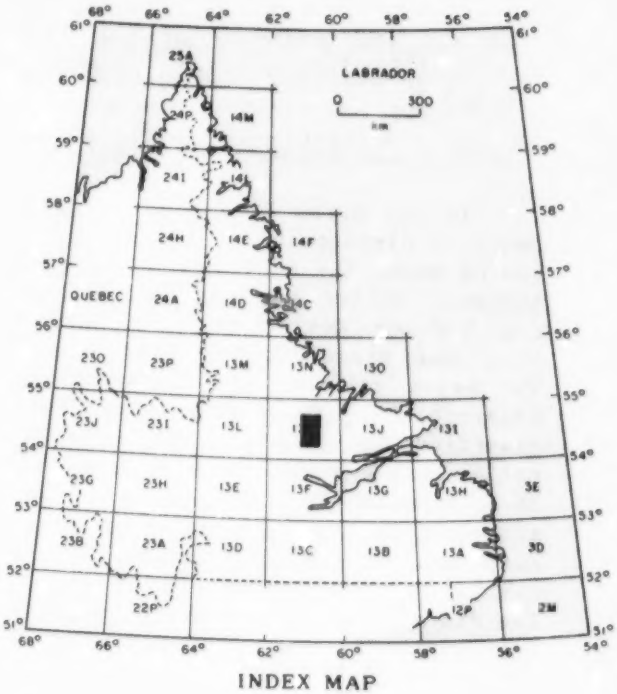


**Figure 1:** Location of study area.

## Location, Access and Geology

Moran Lake is situated in the Kaipokok River system 60 km upstream from Kaipokok Bay, a 50-km-long arm of the Labrador Sea. Goose Bay is located approximately 140 km to the south of Moran lake. Access to the field area is by float plane or helicopter.

The study area lies in the Central Mineral Belt, a series of Proterozoic supracrustal rocks of Aphebian, Paleohelikian and Neohelikian age. In the southern part of the study area around Nipishish Lake, granites of late Paleohelikian age dominate. The central part contains volcanosedimentary rocks of the Bruce River Group. These rocks host base-metal and uranium mineralization. The Bruce River Group unconformably overlies the Moran Lake Group, a sequence of sedimentary rocks overlain by mafic volcanics. This group has several base-metal showings but no uranium. The Moran Lake Group, in turn, unconformably overlies Archean gneisses and granites of the Kanairiktok intrusive suite that outcrop in the northern part of the study area.

## Field Program and Initial Results

A helicopter supported mapping program covered the study area at a spacing of roughly 2 by 2 km, al-

though this was reduced to nearer 1 by 1 km in areas of either complex flow or terrain. At each site data were collected on the terrain (landform type, drainage, vegetation and local relief), a test-pit dug, and soil and parent material described (type, thickness, compaction, structure, colour and clast content and type). Local bedrock was examined for type and the presence of ice flow direction indicators, commonly striae.

## Terrain and sediment distribution

In the Moran Lake area a simple two-fold distinction of terrain types can be made. The valleys are commonly sediment filled whereas the uplands are bedrock dominated, and have a thin and discontinuous till cover. The major valleys, the Kaipokok and Kanairiktok, both contain significant quantites of material. The Kaipokok valley below Moran Lake is composed of a sequence of deltaic sand and gravel that have a series of plane surfaces, the highest about 120 m a.s.l. and the lowest at 105 a.s.l. The distal side of the delta overlies fossiliferous, red, silt and clay of marine origin that dominate the valley below an elevation of about 100 m. In contrast, the Kanairiktok valley is dominated by glaciofluvial sediments and associated eskers. However, fossiliferous marine sediments reaching a maximum altitude of about 100 m were observed beneath the outwash. In contrast to the generally massive marine muds in the Kaipokok valley, marine sediments in the Kanairiktok valley were commonly laminated. The contact between the Kanairiktok and Kaipokok valley system is marked by a sequence of deltaic sediments. Other smaller valleys in the study area commonly contain outwash and esker deposits.

## Glacial-flow patterns

The considerable bedrock exposure across the study area provided a good distribution of striae. Striae directions varied from southeastward to northward, and can be categorized into three separate groupings. The southern and eastern parts of the study area commonly reveal evidence of only one dominant flow event, toward the northeast (040 to 050°). This flow direction is consistent through the central part of the area between Bruce Lake in the south and the Kanairiktok valley in the north, but is here superceded by a flow event toward the east (075-090°). This event is commonly confined to elevations below 330 to 360 m a.s.l., and is concentrated in the western part of the study area. North of the Kanairiktok River flow patterns are east northeastward.

The directions of glacial flow recorded by the erosional evidence is also reflected in the dispersal patterns of clasts across the area. Two main bedrock markers were selected because they have a small surface expression and are visually distinctive. Dispersal from a pink, buff or green porcelanite member of the Brown Lake Formation that outcrops in the Croteau Lake area was consistent with the easterly flow direction in the vicinity of Moran Lake, but down-ice of this point demonstrates a marked northeasterly shift. This is consistent with the influence of the northeasterly flow event that is commonly the most recent flow event across the area. A similar pattern is noted in the dispersal of a coarse grained plagioclase porphyry that outcrops in the Brown Lake Formation around Camel Lake. The patterns produced by dispersal from the bedrock source represents a regional response to glaciation. Local responses, in the order of 1 km or less were determined by the detailed sampling (100- to 200-m spacing) of till in the vicinity of known mineralization. Several base-metal occurrences were selected, although data is not yet available.

## Mineral exploration implications

The glacial literature on the Central Mineral Belt commonly describes the 'simple' flow patterns through the area. This seasons field work has demonstrated that such a notion is incorrect and that complex patterns exist, not only in the erosional environment (i.e., striae) but also in the way in which material is transported through the area.

Much of the study area was affected by northeasterly flowing ice. However, in the central part of the area the last phase was easterly, although some of the higher peaks were apparently unaffected by it. Over most of the area at least two flow directions are recorded. The successful resolution of the glacial history of the Central Mineral Belt is critical if mineral exploration in the drift covered areas of the belt is to be successful. The prospective explorationist must be aware of the commonly complex patterns of glacial-flow directions and be prepared to adjust any exploration strategy accordingly.

# Studies of glacial history and glacial dispersal, Labrador

by

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MDA Project 820039, Terrain Sciences Division, Geological Survey of Canada

As part of a project funded by the Canada-Newfoundland Mineral Development Agreement(MDA), ice-flow trends and ages, and patterns of glacial dispersal, are being determined throughout central Labrador to develop a Quaternary geological basis for mineral exploration by drift prospecting (cf. Klassen and Thompson, 1987; Thompson and Klassen, 1986). Emphasis during 1987 fieldwork was placed on a detailed study of dispersal trains and geochemical anomalies identified during previous field seasons (Geological Survey of Canada, Open Files 1318, 1319, 1320), and on an extension of work initiated in the Schefferville region into the Wabush area.

Drift provenance and the trends and relative ages of striae have been used to identify a complex history of ice flow across Labrador. The shifting patterns of ice flow are important for reconstructing the history of the Laurentide Ice Sheet as they indicate the existence of several dispersal centres and suggest that they had a dynamic history. The size, shape and configuration of glacial-dispersal trains directly reflect the varied history of ice flow. They range from simple 'ribbons' streamed along a Labrador coast, to complex 'patches' near dispersal centres in the Labrador Trough. The differences in configuration of the dispersal trains strongly indicate that glacial history is a critical consideration for the effective use of drift in mineral exploration and they provide a basis for developing exploration strategies suited to the different regions of Labrador.

Ice-flow trends determined in the Wabush area during the 1987 field season have been consistent with the results of earlier work (Klassen and Thompson, 1987) and indicate several distinct directions and ages. Not only are the flow trends outlined on the Glacial Map of Canada recorded, but older flow trends have been defined as well. In general, the older flow trends are southward to southwestward while later trends are southeastward to southward.

Compositional evidence of the older flow trends is provided by the distribution of debris originating within the Labrador Trough, north of the Grenville geological province. The unmetamorphosed trough debris is widespread in surficial deposits; it is common to abundant south and east of the Labrador Trough and is rare to the west across the Archean highlands of the Ashuanipi Complex and to the south of Wabush. There is a western margin to the distribution of glacial deposits characterized by abundant trough debris that extends south-southeast from the southwest corner of the trough. The deposits appear to have been transported during both the last and an earlier phase of flow. The occurrence of trough debris to the west and southwest cannot be related to glacial transport during the younger phases of flow but is compatable with transport along trends indicated by oldest striae.

In Schefferville and Wabush stratigraphic sections containing multiple till units and non-glacial sediments have been discovered. The sections provide a key to understanding the glacial history repre-

sented by striae and surface drift composition. In both communities they occur in exposures related to mine workings. The interpretation of the sections is preliminary and requires analysis of drift composition and sedimentary structures to determine the provenance and stratigraphic significance of the different units. Nevertheless, their potential importance is clear as no equivalent stratigraphic sections are known elsewhere in the region.

Within the Scully Mine at Wabush, wood-bearing lacustrine sediments occur stratigraphically between till units that appear to be compositionally distinct. Because Wabush is located within the centre of Labrador-Quebec, the growth of trees would only occur when the ice sheets had disappeared, and hence the wood fragments are associated with an interglacial period.

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1986: Ice flow directions and drift compositions, central Labrador. In Current Research, Part A, Geological Survey of Canada, Paper 86-1A, pages 713-717.

# Quaternary mapping for drift prospecting, Mount Sylvester (2D/3) map area

by

David N. Proudfoot
Quaternary Geology Section

Regional Quaternary mapping (1:50,000) was initiated in the Mount Sylvester map area (Figure 1) to provide a basis for anomaly interpretation in drift exploration. Active mineral exploration is being carried out within the Bay D'Espoir Group for gold at Kim Lake, to the southwest, and for tungsten in the Conne River Pond area to the northwest. Most of the eastern half of the map area is within the Bay du Nord Reserve where exploration is prohibited. This study combines terrain and materials mapping, stratigraphy, sedimentology and glacial flow history. Access to the area is good in the west near Highway 360; however, extensive bog cover and a lack of forest roads limit backhoe access to within a few kilometres of the highway.

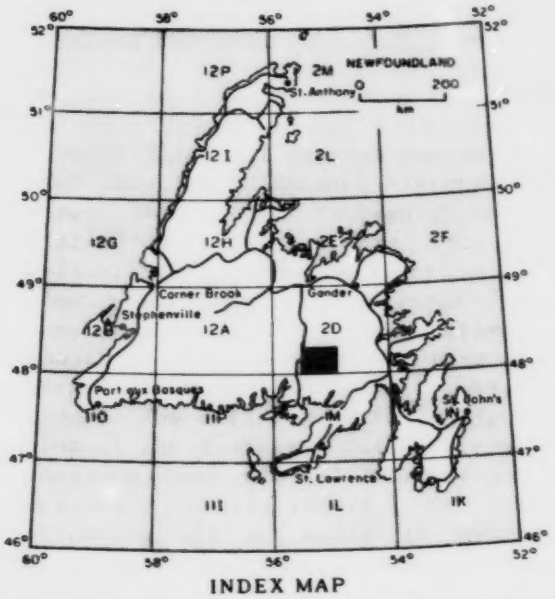


**Figure 1:** Location of study area.

## Geological Setting

The Mount Sylvester area is located in east-central Newfoundland about 25 km northeast of Milltown, Bay d'Espoir. It contains early Paleozoic sedimentary and volcanic rocks and syntectonic granitoids within a northeast- trending part of the Hermitage Flexure and includes Bay d'Espoir Group and Gander Group rocks (Dickson, 1987; Swinden and Dickson, 1981). Mineralization within the stratified rocks in the study area appears to follow this northeast trend.

## Regional Quaternary Geology

Glacial flow was predominantly southeastward (160-170°), as reflected by the numerous streamlined landforms across much of the central part of the area. Unfortunately, glacial striations and grooves preserved only on siliceous sedimentary rocks and on small quartz veinlets are extremely rare, particularly on Middle Ridge and southeast of Jubilee Lake. Surficial sediment is generally thin and discontinuous, with bare rock exposed or directly underlying bog (generally less than 3 m) in many areas. Glacial landforms and sediment indicate that two major glacial environments predominated. In the northern part of the map area, widespread hummocky moraine covered in boulders suggests melting out of sediment from an englacial position. It is likely that material in the hummocks was transported from the north beyond Middle Ridge. Sediment cover here is discontinuous, with thin drift occurring in low areas

between hummocks. In the central part of the area between Middle Ridge and the south side of Jubilee Lake (including much of the Isle Galet Formation), subglacial erosion and lee-side deposition were dominant. Scattered small hummocks superimposed on larger streamlined landforms suggest that melting out of sparse englacial sediment occurred during glacial retreat. Preliminary interpretation suggests that there is only one till in the area.

## Drift Exploration

This study is designed to provide base data on ice flow directions and the genesis of sediment so that the optimal sediment for sampling can be identified. It will also provide a basis for the interpretation of anomalies in drift. It is suggested, based upon experience in other areas, that sampling along the hummocky parts of Middle Ridge should avoid hummock tops. Basal till is more likely to be near the surface in local depressions, however, care must be taken to penetrate thin (less than 1 m) basin-fill sediment. South of Middle Ridge, in the area dominated by streamlined landforms, basal till can be sampled within 1 m of the surface. In exploration programs that are analyzing for detrital gold, it is recommended that samples be taken from as close to bedrock as possible and where overburden is thick, samples should be taken at least 2 m below the surface.

One of our objectives is to develop a better way of obtaining samples and digging stratigraphic control pits. A small backhoe (Cricket Tow-All) transportable by helicopter or pick-up truck was tested for digging in inaccessible areas. The machine has a depth capability of about 2 m, although in our testing in cobbly till we were unable to penetrate more than 1.5 m. This backhoe was less productive than digging shallower pits (1 m) by hand in dry areas but is quite useful for obtaining bulk samples from below shallow bog. We hope to test a modified version of this machine in 1988 that should dig faster and deeper.

## References


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Swinden, H.S. and Dickson, W.L.
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# Quaternary mapping and drift exploration, Port Saunders (121/10,11) map area

by

David N. Proudfoot and Lloyd St. Croix
Quaternary Geology Section

The Mississippi Valley-type zinc mineralization that is being mined in the Daniel's Harbour area (Newfoundland Zinc Mine) occurs in several showings on the carbonate coastal lowland that extends northward to the Port au Choix area. Consequently, regional Quaternary mapping was continued in 1987 (Figure 1) to provide a basis for mineral exploration and to add to the 1:50,000 scale mapping begun in the Daniel's Harbour area in 1986. The approach involves airphoto interpretation with follow-up field checking, description and sampling of existing exposures supplemented by backhoe excavations, geochemical and grain-size analysis of diamicton (mostly till) and ultimately, a sedimentologic interpretation of sediment distribution and genesis. Logging roads provide good access in much of the southern part of the area but in the north, and adjacent to the Long Range Mountains, helicopter support was used.

## Geological Setting

The map area is confined to the coastal lowland between the Long Range Mountains in the east and the Gulf of St. Lawrence in the west. It is underlain by rocks that are mainly carbonates of Cambro-Ordovician age (Knight and Boyce, 1984). Mineralization (mainly zinc) is strata-bound and occurs in small pods within the upper part of the Catoche Formation (Newfoundland Zinc Mine; Lane, 1984) and in showings along the contact between the Watt's Byte and Boat Harbour formations. Northeast-southwest-trending faults are thought to have controlled mineralization.

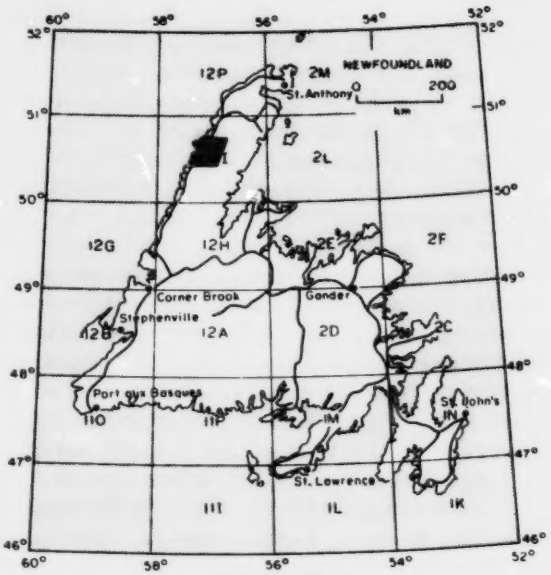


**Figure 1:** Location of study area.

## Regional Quaternary Geology

Quaternary sediment cover is discontinuous, generally with the thickest accumulations in low areas. An extensive area of trees and bog overlying bare rock occurs east of Port au Choix west of Highway 430. Most of the area lies below the Late Wisconsin marine limit of 134 m a.s.l. so that near surface materials have been reworked by nearshore processes to varying extents. Regionally, it is thought that the Long Range Mountains were the source for a major ice cap during the Late Wisconsin. Valley glaciers flowed westward from this ice cap onto the coastal lowland where they coalesced to cover it. Preliminary geologic interpretation is similar to the Bellburns (121/5,6) map area and

indicates the following Quaternary history:

1. One or more glacial advances from a source in the Long Range Mountains to the east. This advance(s) flowed southwestward (250°) from the south side of the Highlands of St. John and terminated seaward of the modern coastline. This interpretation is based on abundant glacial grooves and striations and the orientation of pebbles in till. It is likely that these glaciers terminated in the sea as they advanced across the coastal lowland.

2. Subsequently during this advance or a later advance, these piedmont glaciers spread out leaving grooves and striations near the modern coast that cross 250° indicating flow toward the south and the northeast.

3. During Late Wisconsin glaical retreat, the sea transgressed the area to the flanks of the Long Range Mountains. A well formed cobbly beach that occurs at about 123 m a.s.l. along the west side of the Highlands of St. John is at or near this marine limit.

4. Reworking of surface sediment by nearshore processes occurred during marine regression to the modern sea level. During this time major sea level stands occurred at 76, 30 and 14 m a.s.l.

## Drift Exploration

The emphasis of this project is toward the development of a sound geological framework (map, stratigraphy, ice-flow history and sediment genesis) as a basis for future drift-prospecting programs. This work will identify optimal sediment-sampling strategies within each map unit and will help to determine anomaly source directions. In addition, it should give a good indication of where secondary hydrologic anomalies are likely to be close to underlying bedrock sources. Analysis of a detailed sampling program carried out in 1985 (Mihychuk, 1986) prior to regional Quaternary mapping indicates that it was not effective because of assumptions made without the regional geologic context. Furthermore, systematic reconnaissance level geochemical sampling of drift, within the context of limited field and laboratory resources (Proudfoot, 1987) is not effective. A detailed sampling program must be optimized using the type of Quaternary geological framework being constructed for this project. Subsequently, finer sampling grids can be located in small areas to detect this small type of deposit.

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# Quaternary mapping - east half of the Gander River (2E/2) area, Newfoundland

by

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Quaternary Geology Section

## Introduction

The Gander River Ultrabasic Belt (Grub Line) recently has been the target of exploration for gold mineralization. The area (Figure 1) has an extensive cover of overburden, and outcrops are generally scattered or restricted to streams and some hilltops.

The main objectives of this study are to determine the distribution of surficial landforms, and the direction of glacial transport, and to assess the glacial dispersion of gold in this depositional environment.

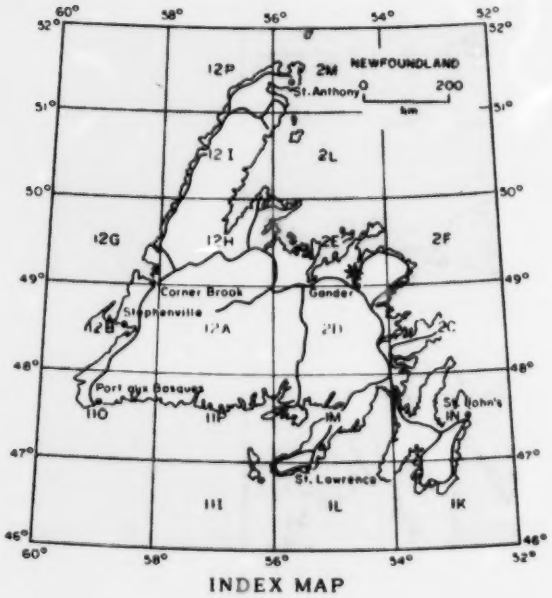



**Figure 1:** Locations of study area.

## Geological Setting

Most of the gold exploration in the area is centred in the Gander River Ultrabasic Belt, which consists of medium to coarse grained pyroxenite, serpentinite, magnesite and talc/tremolite schist, mafic flows, fine to medium grained volcaniclastic rocks, fine to coarse grained trondhjemite, and quartz and quartzfeldspar porphyry (Blackwood, 1982). The GRUB Line is bounded on the west by comglomerate, sandstone, siltstone and grey to black and minor red slate of the Davidsville Group. Semipelite, pelite and psammite of the Gander Group (including minor mafic tuff or amphibolite bands) occur to the east of the GRUB Line.

## Surficial Landforms

The distribution of the surficial landforms is summarized as consisting of 20 to 25 percent wet or boggy areas, and a till thickness of 1 to 5 m over the remaining area; locally till thickness ranges from 5 to 10 m (based on backhoe test pits and hammer seismic survey). Some of the major river valleys contain deposits of glaciofluvial sediments.

## Glacial Transport

Mapping of glacial features (Figure 2) indicate that there were two glacial flows in the study area; an earlier flow toward the east (080 to 100) and a later flow generally toward Gander Bay to the north (000 to 030).

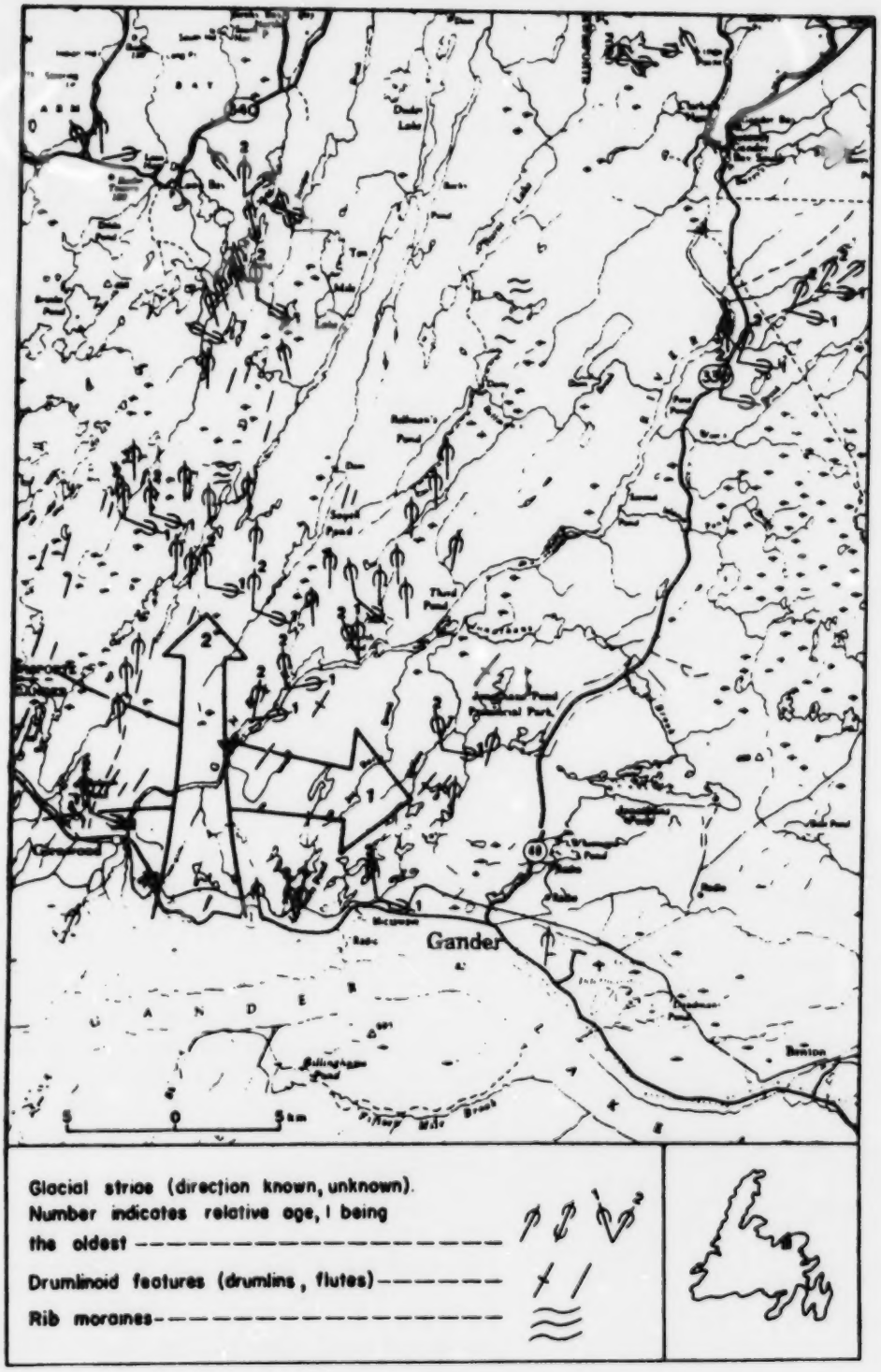



**Figure 2:** Glacial flow, Gander area.

## Glacial Dispersal

The variable nature of these two glacial flows raises questions concerning the resultant pattern of glacial dispersion. Detailed sampling along Jonathans Pond was undertaken to help define a dispersal pattern. The sampling program had the cooperation of Noranda Exploration Co. Ltd. who supplied us with a cut grid and other general information.

Till sampling was carried out over a grid extending from the western boundry of Jonathans Pond Provincial Park west along Jonathans Brook to Jonathans Second Pond, and 2 km to the north (Figure 1).

Most sampling was conducted, along cut lines spaced 100 to 200 m apart, at 100- to 200-m intervals along the line. Pebble samples will be analysed for lithological composition, and matrix samples for textural (grain size) and geochemical variations, to determine glacial dispersal patterns.

## Reference:

Blackwood, R.F.
1982: Geology of the Gander Lake (2D/15) and Gander River (2E/2) areas. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 82-4, 56 pages.

**Diatomaceous earth and bedrock aggregate study, eastern Newfoundland**

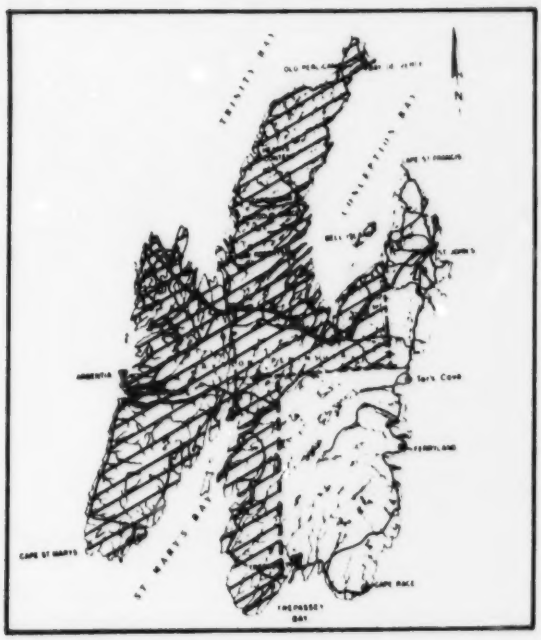
by

Dan Bragg
Quaternary Geology Section

The 1987 field season (Figure 1) was divided into two sections. For the first half of the season work concentrated on finding new deposits of diatamaceous earth using last years study procedures. The second half of the field season focused on bedrock aggregate potential for industrial use.

## Diatomaceous Earth

The area from Tor's Cove to Trepassey (Figure 1) was chosen because of a new diatomaceous earth deposit that was found during last year's field season and because of numerous bogs in the area. A total of five large bogs were chosen for detailed investigation from the numerous sites visited.



Bedrock aggregate survey

Diatomaceous-earth survey

**Figure 1**: Location of study areas.

Investigation consisted of hand-drilled coring at 20-m-intervals in a grid fashion; each core sample would be described and kept, depending on the quantity and quality of material present in core.

A total of 200 core sites were hand drilled and 60 samples taken. These core sample sites ranged from .5 m to 4 m in depth and contained diatomaceous earth that ranged in thickness from 2 cm to 1.1 m. However, most sample sites ranged from .5 m to 1.5 m of peat with no diatomaceous earth, indicating poor expectations for the area.

## Bedrock Aggregate Potential

The 1987 field season saw completion of bedding aggregate mapping at a 1:50,000 scale for the Avalon and Burin peninsulas (Figure 1).

Field work consisted of traverses along the Trans-Canada and southern shore highways, and various side roads, including visits to all known quarries in the area. Road-cuts and coastal outcrops were sampled where no rock quarries existed.

Field investigations for each site involved representative sampling, determining (where possible) land ownership, previous and present use, recording thickness and type of overburden and making general geological and geotechnical observations

such as: rock type, structures (faulting, folding, jointing, fracturing, bedding, etc.) and mineralization. Veining and alteration zones were also noted.

A total of 283 sites were visited and 241 samples taken. Thin sections will be made of all samples and petrographic analyses completed. Petrographic numbers will be established for each sample.

## Aggregates for Export

by

M.J. Ricketts
Quaternary Geology Section

An aggregate resource program was conducted in the Bay St. George area (Figure 1) to locate deposits of gravel and sand for export markets. The area was chosen because of year round ice-free conditions and available wharf facilities already in place.

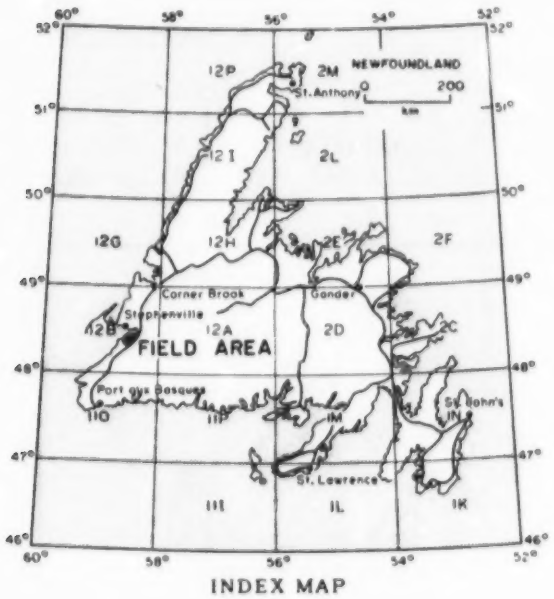



**Figure 1:** Location of study area.

The objectives of the study were to locate deposits of sand and gravel (Figure 2) and determine the quality and quantity of material in these deposits. This was achieved by detailed sampling (first by pick and shovel and later by backhoe pits) to provide material for petrographic and particle size analysis. Deposit quantities were estimated based on sample locations, landform and aerial photographs.

Field work was concentrated in areas around the Flinkote gypsum mine and in deposits in close proximity to the 10-km-long haul-road, leading from the Flinkote mine to the wharf, where gypsum is loaded for export. Available facilities in this area, namely the wharf, and the haul-road that gives easy access to the shoreline, will provide a competitive edge over other areas in Newfoundland.

Potential aggregate extraction areas were sampled at Seal Rocks (Zone 1 and 2), St. Georges (Zone 3), Little Barachois Brook (Zone 4), Shallop Cove (Zone 5), Flat Bay Brook (Zone 6), Rushy Pond (Zone 7), Longbyes Pond (Zone 8) and a few zones bordering the southern end of the Flinkote mine (Zone 9).

Zone 1: This zone contains an estimated 8,000,000 $m^3$ of material composed predominantly of medium to fine sand, some pebble, and a higher silt/clay content at locations determined from visual observations along a 2-km-stretch of shoreline. A 6-m-high face of clay is exposed along a 150-m-stretch of shoreline where it is overlain by 6 m of sand. Petrographic numbers in this area range from 107 to 125 with an average of 114 for 3 samples analyzed.

Zone 2: This zone contains an estimated 4,000,000 $m^3$ of material composed predominantly of gravel of variable texture as determined from 6 backhoe pits (averaging depths of 3 m). A 5-m-quarry exposure at the top of this deposit showed 2 m of stratified gravel and sand overlying an undetermined thickness of sand. It

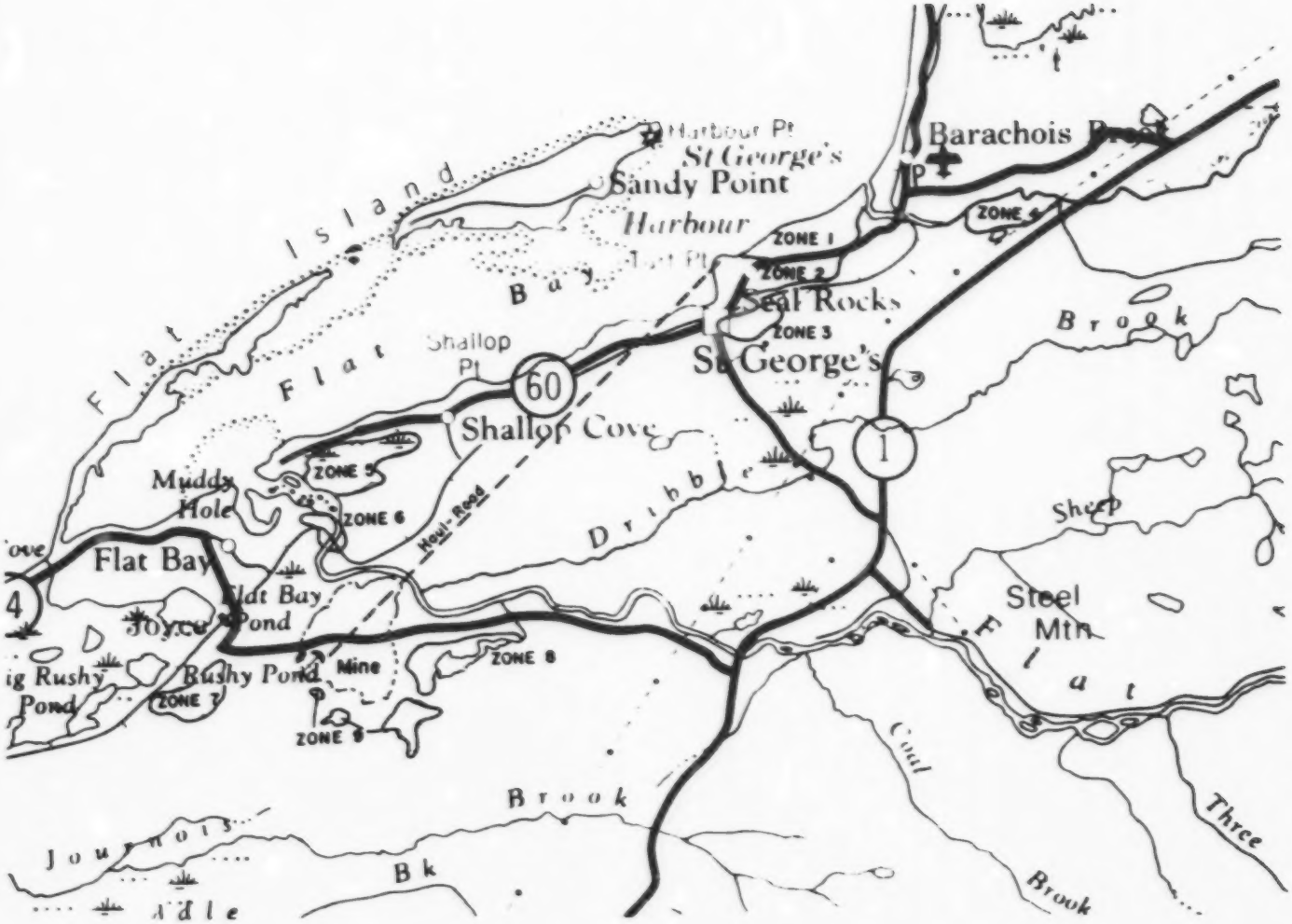



**Figure 2:** Study area showing aggregate-resource zones.

is assumed that the material beneath the level of backhoe pits is composed of sand texture similar to that observed along the 2-km-long shoreline exposure described in Zone 1. Petrographic numbers range from 102 to 155 with an average of 120 for 7 samples analyzed.

Zone 3: This zone contains an estimated 3,000,000 $m^3$ of material and is composed predominantly of sand of variable size. A gravel sample collected in this area has a petrographic number of 111.

Zone 4: This zone contains an estimated 1,400,000 $m^3$ of material. It is composed predominantly of sand as indicated from a 14 m river cut exposure which shows 3 m of sandy gravel over sand. Two hand-dug pits also revealed sand. Petrographic numbers range from 101 to 137 with an average of 117 for 5 samples analyzed.

Zone 5: This zone contains an estimated 5,000,000 $m^3$ of material. Samples collected from 5 gravel pits and 4 backhoe pits indicate material in this deposit is predominantly gravel and sandy gravel with extensive sand overlain by 2 to 3 m of gravel in localized areas. Petrographic numbers range from 104 to 167 with an average of 128 for 11 samples analyzed.

Zone 6: Preliminary analyses indicate this zone to contain 700,000 $m^3$ of boulder gravel and gravel. Samples collected from stream cuts and road exposures show a range of petrographic numbers from 117 to 184 with an average of 139 for 5 samples analyzed.

Zone 7: This zone contains approximately 600,000 $m^3$ of gravel and sandy gravel. Petrographic numbers range from 119 to 184 with an average of 142 for 6 samples analyzed.

Zone 8: This zone contains an estimated 700,000 $m^3$ of gravel, boulder gravel, sandy gravel and sand. There was a 20 to 25 percent boulder content in 4 of the 8 backhoe pits along the side of eskers. Petrographic numbers range from 106 to 128 with an average of 119 for 12 samples analyzed.

Zone 9: This zone contains approximately 2,000,000 $m^3$ of sand and gravel. Petrographic numbers range from 106 to 159 with an average of 125 for 14 samples analyzed.

# Detailed aggregate resource assessments in Newfoundland

by

F.T. Kirby
Quaternary Geology Section

Detailed aggregate resource assessments were conducted in a number of municipal planning areas throughout the province during the 1987 field season. Areas included in the field program were: (A) Roddickton, Englee, Bide Arm, (B) Roberts Arm and (C) St. John's Peninsula and Conception Bay north (Figure 1).

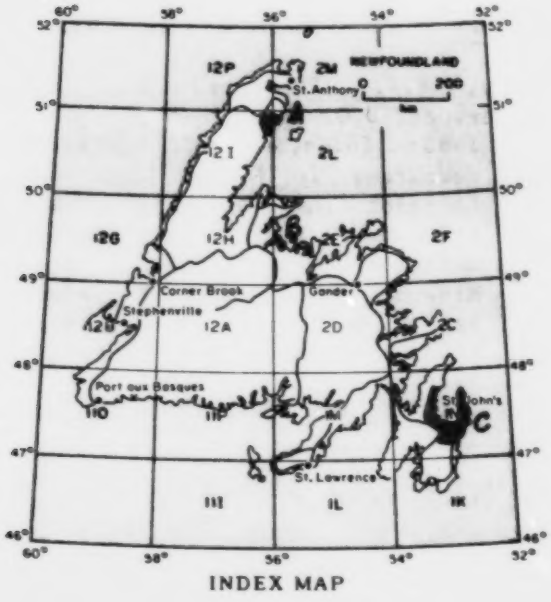



**Figure 1:** Location of study areas.

Prior to commencement of field work all existing aggregate resource data was evaluated (Kirby et al., 1983) and areas for detailed evaluation were selected. Field work involved vehicular and foot traversing throughout the areas to evaluate pre-selected targets and to locate and evaluate new potential targets. Post field season work will involve the preparation of maps and covering letters which will be forwarded to the Department of Municipal Affairs. These maps outline areas of high aggregate potential that are determined from field work and will be included in the municipal plans as aggregate resource areas.

## (A) Roddickton-Englee-Bide Arm (121/9, 16)

This study has verified the results of the original survey conducted throughout the area in 1978 (Kirby et al., 1983). Generally the area is covered by a thin blanket of localized till usually less than 2 m in thickness, with numerous rock outcrops. In the area of Bide Arm Big Pond marine sediments, containing stratified sand and gravel, were identified.

Generally, tills in the area are of poor quality for most aggregate uses, having high silt content and poor petrographic characteristics. The marine sediments, although composed of stratified sand and gravel, have a high silt content and fair petrographic characteristics. The main bedrock units exposed in the study area are carbonate rocks of the Table Head Formation. These rocks are generally suitable as a source of aggregate when fresh and unweathered. A total of twenty-two samples were collected for particle size and petrographic analyses.

## (B) Roberts Arm (2E/5)

The surficial geology of the area is characterized by exposed bedrock, thin till veneers (greater than 1 m) over bedrock and colluvium at the base of some slopes. A glacio-

terrace at Crescent Lake is the only source of good quality surficial aggregate material in this region. This deposit is composed of stratified sandy gravel and sand and is the major source of asphalt-blending sand and concrete aggregate. Approximately 15 percent of the resource is available for extraction. A municipal park and private cabins prevent extraction from most of the remaining deposits.

The major bedrock type exposed in the Roberts Arm area is basalt with interbedded cherty sediments. Where fresh and unweathered, these rocks are suitable for most aggregate uses. A total of twenty-six aggregate and bedrock samples were collected for particle size and petrographic analyses.

(C) St. John's Peninsula and Conception Bay North (1N/6/7/10/11/14/15)

Field work in this area was divided into two segments. The first segment involved a hammer seismic evaluation of selected aggregate resource sites throughout the St. John's Peninsula. This study was undertaken to evaluate the performance of a Huntec FS-3, Portable Facsimile Seismograph (Hammer Seismic) in different terrain and overburden. It is hoped that this unit will enable us to determine the overburden depth in areas of high aggregate potential. The success of this program will be evaluated when the results of the sixty-five seismic profiles taken are interpreted.

The second segment involved the collection of representative bedrock samples. These samples were taken to evaluate the potential of each rock type as a source of crushed aggregate.

Reference

Kirby, F.T., Ricketts, R.J. and Vanderveer, D.G.
1983: Inventory of aggregate resources in Newfoundland and Labrador, information report and index maps. Newfoundland Department of Mines and Energy, Mineral Development Division, Report 83-2 and Open File Maps NFLD 1287 (Maps 83-06, 83-13, 83-15).

# GENERAL PROJECTS

# Core Storage Program, 1987

by

A. Harris and S. Cochrane
Publications and Information Section

During 1979, the Newfoundland Department of Mines started a drill core collection and storage program. The objective is to provide well maintained and representative collections of drill core from as many drilling programs as possible for the future use of the mineral exploration industry, government geoscientists, university geoscientists and other geotechnical people.

## Drill Core Acquisition

During 1987 drill core acquisition continued in insular Newfoundland. A total of 60,878.2 m of drill core were added to our collections this year. Of this total 48,880.5 m were acquired from Western Canadian Mining (old Brinex drilling) when the Department leased a core storage building located on the former Brinex base camp at Springdale. Another 5,608.5 m of core were collected by project personnel and 6,389.2 m of core were delivered to our facilities, for confidential storage, by mineral exploration companies.

Activities in Labrador this past year were limited to the inspection of company core storage sites in the Eastern Central Mineral Belt and in western Labrador, and the cataloging of core collected during 1986.

## Drill Core Libraries

The Department of Mines now operates four core libraries. The core libraries located at St. John's, Pasadena and Goose Bay have similarly equipped core examination laboratories. The labs contain rock cutting equipment, a core splitter, a stereomicroscope, a magnetic susceptibility meter, a resistivity meter, ultraviolet light and a McPhar TV-1 scintillometer. The recently leased Springdale facility has a core splitter and a rock saw and will share other equipment with Pasadena.

The three core libraries now house a total collection of 246,800 m of drill core of which approximately 202,403 m are classified as 'open' and are available for inspection by interested persons.

All 'open' core in our four core libraries is listed in the updated version of Open File NFLD 1479.

The core storage program is presently storing 44,297 m of core on a confidential basis. Requests for confidential storage are treated on an individual basis and are generally accommodated where sufficient space is available in our core libraries, subject to the terms and conditions affecting the confidential storage of drill core samples.

## Plans

The construction of core storage racks in the proposed Buchans core storage library will be completed within the 1987-88 fiscal year. It is anticipated that all core available from the Buchans co-tenancy of ASARCO and Abitibi-Price will be moved into this building in 1988.

The core storage program is experiencing a worsening space problem as our core sample collections continue to increase. The Department is taking a two-pronged approach to

the space problem by 1) pursuing expansion to existing facilities and acquiring or renting new core storage facilities and 2) adopting a policy of selective core collection and reduction.

Preliminary guidelines for core reduction have been drafted and are being applied to our core collection from the Deer Lake Basin. The results of this exercise will be reported in Current Research for 1987.

Any comments from the mineral exploration industry regarding the practice of condensing or telescoping core would be welcome.

## GEOSCAN - The national database for geological information

by

Catherine Patey
Publications and Information Section

GEOSCAN is a computerized bibliographic database of Canadian-produced and/or Canada-related geoscience documents.

The Newfoundland Department of Mines and Energy is one of the ten agencies that index documents for input into this databse. Our Mineral Assessment Report Library files and mineral inventory cards are the sources of our indexed documents. Other agencies, e.g., the Geological Survey of Canada and the Earth Physics Branch of the Canada Department of Energy, Mines and Resources, also produce and index documents that concern this province.

In 1982, the National GEOSCAN Centre, which manages GEOSCAN, implemented a new software system, and most of the old records were converted to a new format.

During the past year, detailed modifications of all of the converted assessment-file records were made online.

All of the 95,000 GEOSCAN records from across Canada, including those concerning this province, are available through online computer searches at the Geological Survey of Canada Library in Ottawa, and in St. John's at our Publications and Information Section.

# Mineral occurrence data system

by

C.F. O'Driscoll, J. Smith and G. Stapleton
Mineral Deposits Section

The Mineral Occurrence Data System is a two-part project designed to offer an efficient information service on all the mineral occurrences in Newfoundland and Labrador. It consists of a manual Mineral Inventory File and a computerized Mineral Index.

The Mineral Inventory File is part of the national Mineral Inventory and consists of mineral-occurrence descriptions that summarize all data on known mineral occurrences in the province. At present the file contains approximately 3,500 descriptions. All mineral occurrences for the Island of Newfoundland have been compiled (Figure 1). Areas in Labrador (Figure 2), which contain the majority of known mineral occurrences, have also been compiled. The file and topographic location maps have been microfiched and duplicates are available upon request.

Mineral-occurrence maps that have updated geological bases have been published at a 1:250,000 scale and are available upon request. In addition selected areas have been published at 1:50,000 and 1:100,000 scales. Maps that have been released this past year include the St. Alban's map area at 1:50,000 scale and the south-central Labrador Trough at 1:100,000 scale. These maps contain locations as well as a listing of the occurrences, including the name, status and minerals present.

The computerized Mineral Index contains information selectively extracted from the Mineral Inventory File. The purpose of the index is to organize important data so that a wide variety of retrievals can be made. It is presently being transferred from the Newfoundland and Labrador Computer Services, where it has previously resided, to the Division's computing system. The file can be accessed at the Department of Mines' offices in St. John's.

The manual Mineral Inventory File is used as a quick reference to specific deposits. It is used daily by exploration company personnel and by government geologists. The file is available to anyone who is researching mineral deposits in the province.

By the use of computers, the retrieval capability from the computerized Mineral Index is optimized and complex retrievals can be made that would be virtually impossible if a manual system were used.

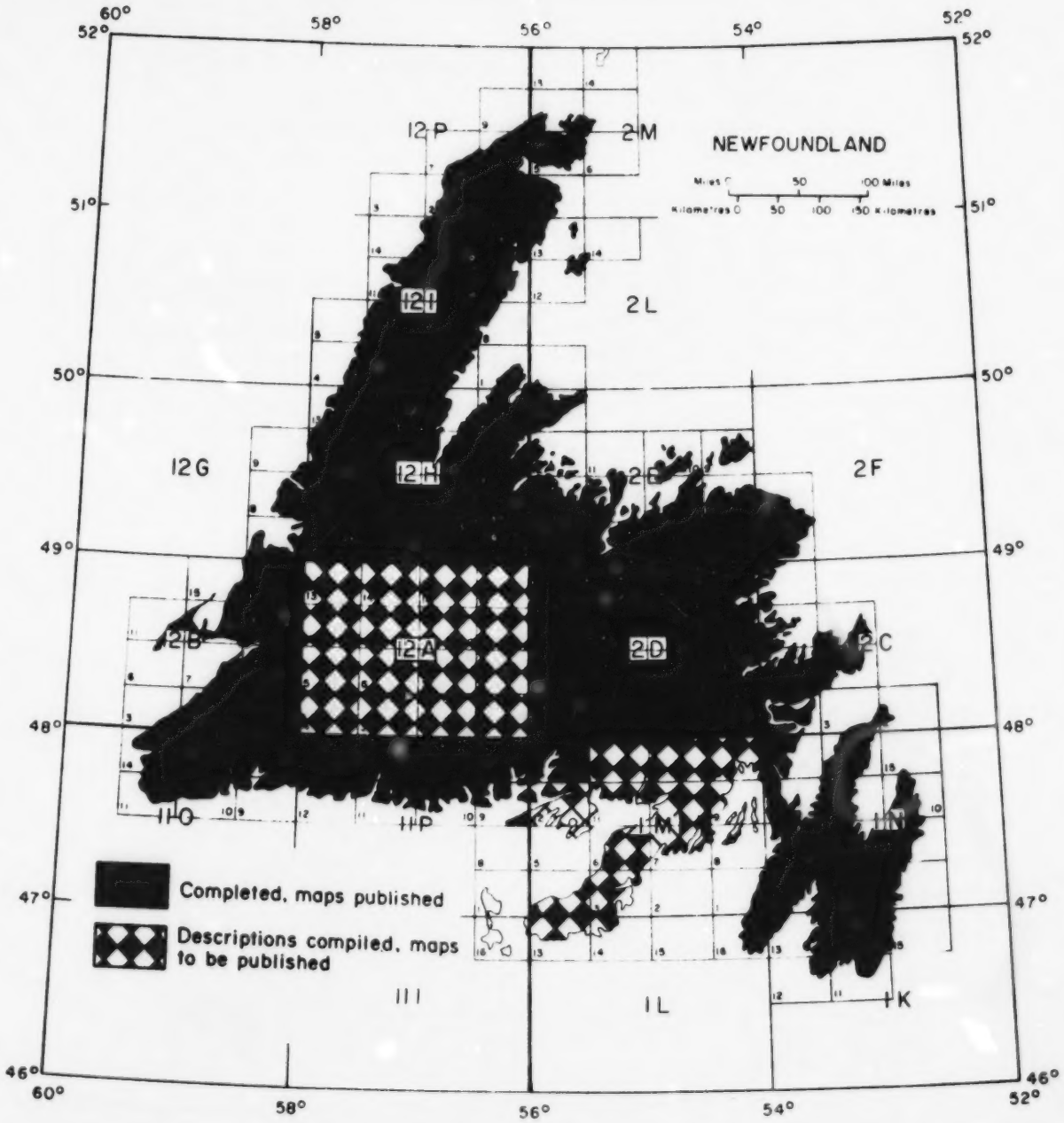



Figure 1: Index map for Mineral Occurrence Data System project, insular Newfoundland.

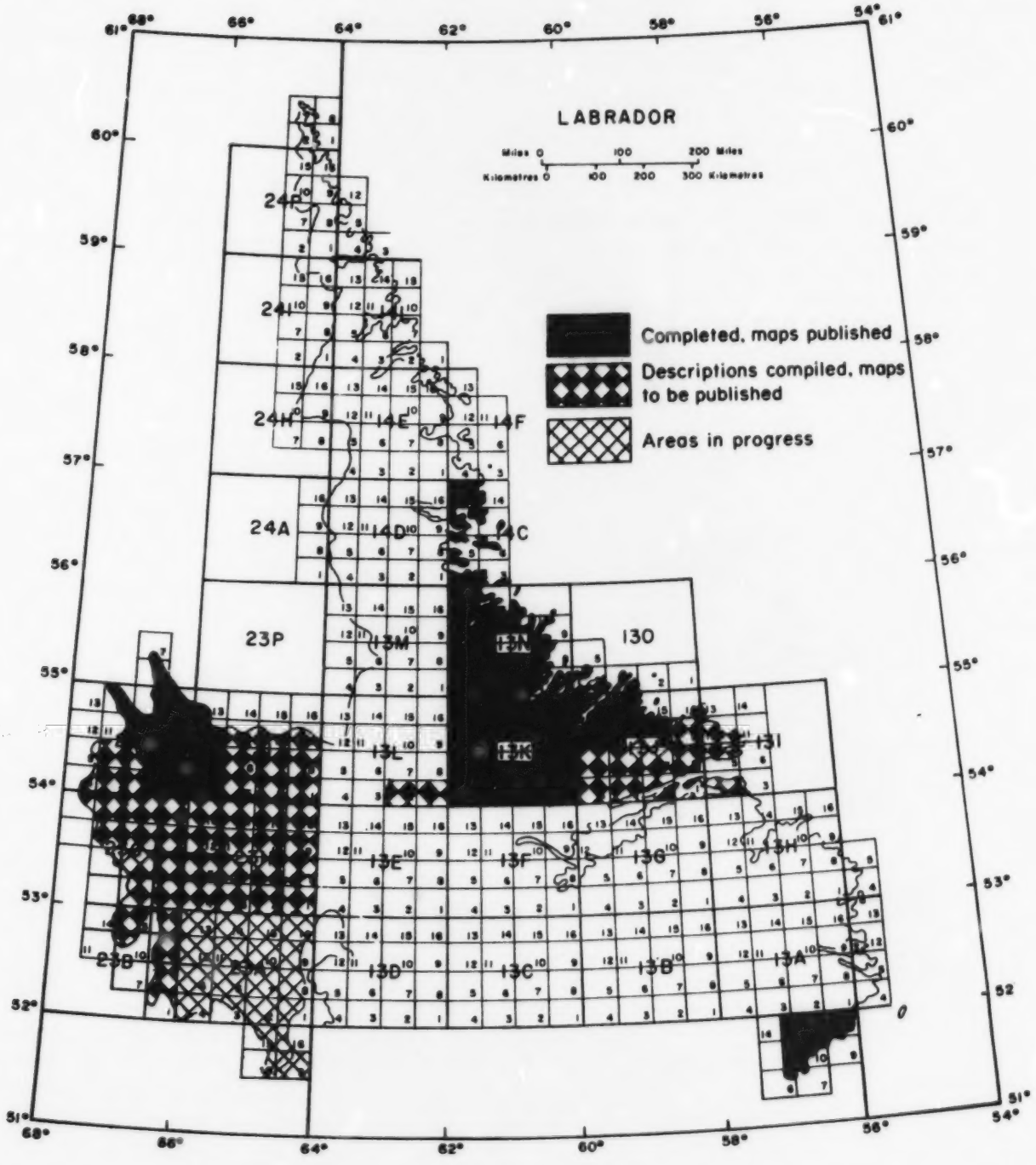



Figure 2: Index map for Mineral Occurrence Data System project, Labrador.

# Report of the Mineral Laboratory for 1987

by

H.A. Wagenbauer and C.A. Riley
Geochemical and Geophysics Section

The number of determinations performed by the Mineral Laboratory for the last 12 months ending August 31, 1987 is summarized in Table 1. The total number of 172,362 determinations for this period is an increase of 32 percent over last year. The analytical work on the samples collected during the 1986 field season is about 95 percent complete.

At present the Mineral Laboratory is performing nearly all the analytical work required by the department. Analysis performed by outside organizations is now limited to those techniques where the detection limit is below the analytical capability of the Mineral Laboratory and sophisticated instrumentation such as Neutron Activation and ICP-MS is the most cost- efficient method of analysis.

To the seven elements (Ga, Nb, Zr, Th, Y, La, Ce) analysed by ICP in 1986, 13 more elements (B, Al, Fe, Mg, Ca, Li, Na, K, Ti, Ba, Sr, Bi and V) were added for major oxide and trace determinations in rocks, till, lake and stream sediments, and are now analysed by ICP when required.

Table 1: Summary of output from the Mineral Laboratory, for the period September 1, 1986 to August 31, 1987.

| | | |
|---|---|---|
| Geochemical analysis of soil, till, lake and stream sediments | | 43,833 |
| Silicate analysis | | |
| Major elements | A.A. | 34,993 |
| | ICP | 2,965 |
| | Photometric | 4,432 |
| | Classical | 5,781 |
| | Potentiometric | 4,033 |
| Trace Elements | A.A. | 36,693 |
| | ICP | 39,293 |
| Miscellaneous Analysis; Assays, $H_2O^-$, $H_2O^+$, $CO_2$, S | | 339 |
| | TOTAL: | 172,362 |
| Sample Preparation | | |
| Rock samples crushed | | 3,331 |
| Rock samples pulverized | | 3,945 |
| Lake, stream and soil samples sieved | | 3,320 |

Table 1 (Concluded)

| | |
|---|---|
| Miscellaneous | |
| Samples split, samples shipped for outside analysis, samples renumbered | 5,284 |
| Samples weighed for outside analysis | 8,565 |
| Quaternary Lab | |
| Samples split | 1,150 |
| Samples siphoned | 1,066 |
| Samples wet sieved | 1,124 |
| Samples dry sieved | 1,480 |
| Coulter Analysis | 2,776 |